



# Individual Learning Program

In

## AMATEUR RADIO

(NOVICE LICENSE)

1  
RULES AND  
REGULATIONS

THE  
NORTHAMPTON

THE NORTHAMPTON

THE NORTHAMPTON



# Individual Learning Program

## AMATEUR RADIO (NOVICE LICENSE)

### *Module 1* RULES AND REGULATIONS ER-3701

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## MODULE OBJECTIVES

When you complete this module, you will be able to select:

1. The three main purposes for the existence of the amateur radio service.
2. The definition of the amateur radio service.
3. The definition of an amateur radio operator.
4. The definition of an amateur radio station.
5. The definition of a control operator.
6. The definition of a station license.
7. The definition of a primary station.
8. The novice frequencies within the 80-meter band.
9. The novice frequencies within the 40-meter band.
10. The novice frequencies within the 15-meter band.
11. The novice frequencies within the 10-meter band.
12. The type of emission a novice may use.
13. The maximum power a novice may use.
14. The length of time a novice license is good for.
15. The maximum height above ground an antenna structure may be at a given distance from an airport.
16. The responsibility of a station licensee and a control operator.
17. The times during a transmission when you must identify your station.
18. The type of one-way transmission that is not permitted.
19. Who is eligible for a novice license.

20. Who is eligible to obtain a station license.
21. The definition of a log.
22. The information required in a log.
23. The length of time you must retain a log.
24. Four methods of measuring the frequency of the emissions from a transmitter.
25. Who an amateur station may communicate with.
26. The number of days you have to answer a Notice of Violation from the FCC.
27. A statement concerning when station operation may be restricted by the FCC.
28. The types of communications which are prohibited.
29. The time when third-party traffic is permitted.
30. The reasons the FCC may modify a license.
31. The place where the operator license must be kept.
32. The place where the station license must be kept.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than six questions, read this whole module.
  - If you have less than six incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parenthesis, following the correct answer, refers you to the proper frame) or you can skip this module and proceed to the next module.
1. Which of the following is **not** one of the main purposes for the existence of the amateur radio service?
    - A. To create a reservoir of trained radio operators and electronics experts.
    - B. To provide a voluntary, non-commercial communication service for the public that is especially useful during an emergency.
    - C. To advance the state of the art.
    - D. To provide a voluntary, commercial communication service for the public that is especially useful during an emergency.
    - E. All of the above.
  2. Select the best definition of the amateur radio service.
    - A. The amateur radio service is a radio communication service of self-training, intercommunication, and non-technical investigation carried on by amateur radio operators.
    - B. The amateur radio service is a group of people interested in communicating with other people.
    - C. The amateur radio service is a radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.
    - D. The amateur radio service is a radio communication service provided for business purposes.
    - E. None of the above.

3. Select the best definition of an amateur radio operator.
- A. An amateur radio operator is any person who uses a radio for business.
  - B. An amateur radio operator is a telegraph operator.
  - C. An amateur radio operator is a person who operates a radio station.
  - D. An amateur radio operator is any person interested in radio techniques solely with a personal aim, and without any pecuniary (monetary) interest, holding a valid FCC license to operate amateur radio stations.
  - E. An amateur radio operator is any person interested in radio technique solely with a commercial aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.
4. Select the best definition of an amateur radio station.
- A. An amateur radio station is any licensed radio station.
  - B. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio station communications.
  - C. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for broadcasting communications.
  - D. An amateur radio station is a station that consists only of home-built equipment.
  - E. None of the above.
5. Select the best definition of a control operator.
- A. A control operator can only be the licensee of an amateur radio station.
  - B. A control operator can only be the licensee of an amateur radio station or some other operator designated by the licensee of the station to be responsible for the emissions from that station.
  - C. A control operator is any operator, other than the licensee, who uses an amateur radio station.
  - D. The control operator of an amateur radio station is a representative of the FCC.
  - E. A control operator is the person who owns the property where the amateur radio station is located.



6. Select the best definition of a station license.

- A. A station license is the instrument of authorization for a radio station in the amateur radio service.
- B. A station license is the instrument of authorization that includes only the location of a particular station.
- C. A station license is the instrument of authorization that includes only the call sign of the station.
- D. A station license is the instrument of authorization that includes only the class of operator privileges.
- E. None of the above.

7. Select the best definition of a primary station.

- A. A primary station is a station owned and operated by an extra class licensee.
- B. A primary station is any land based amateur radio station.
- C. A primary station is any amateur radio station that operates at full power.
- D. A primary station is the amateur radio station you operate the most.
- E. A primary station is the principal amateur radio station at a fixed land location shown on the station license.

8. Which of the following segments within the 80-meter band may a novice use?

- A. 7100 — 7150 kHz.
- B. 3700 — 3750 MHz.
- C. 3700 — 3750 kHz.
- D. 7.100 — 7.150 MHz.
- E. 7.100 — 7.150 kHz.

9. Which of the following segments within the 40-meter band is authorized for novice use?

- A. 28.1 — 28.2 MHz.
- B. 21.1 — 21.2 MHz.
- C. 7.1 — 7.15 kHz.
- D. 3.7 — 3.75 MHz.
- E. 7.1 — 7.15 MHz.



10. Which of the following segments within the 15-meter band may a novice use?
- A. 21,100 — 21,200 kHz.
  - B. 21,100 — 21,200 MHz.
  - C. 21.100 — 21.200 kHz.
  - D. 21,000 — 21,100 kHz.
  - E. None of the above.
11. Which of the following segments within the 10-meter band is authorized for novice use?
- A. 21,100 — 21,200 MHz.
  - B. 21,100 — 21,200 kHz.
  - C. 28,100 — 28,200 MHz.
  - D. 28,100 — 28,200 kHz.
  - E. 21.1 — 21.2 MHz.
12. What type of emission may a novice use?
- A. A1.
  - B. A~~3~~.
  - C. C1.
  - D. F2.
  - E. A3.
13. What is the maximum power a novice may use?
- A. 1000 watts output.
  - B. 250 watts output.
  - C. 75 watts input.
  - D. 250 watts input.
  - E. 100 watts input.
14. Which of the following is true concerning a novice license?
- A. License is good for two years, renewable.
  - B. License is good for one year, non-renewable.
  - C. License is good for one year, renewable.
  - D. License is good for five years, renewable.
  - E. License is good for two years, non-renewable.

15. What is the maximum height you could construct an antenna if you live two miles from an airport?
- A. 105.6 feet.
  - B. 10.56 feet.
  - C. 105 yards.
  - D. 1056 feet.
  - E. 200 feet.
16. Which of the following is responsible for the proper operation of an amateur radio station?
- A. The control operator(s) only.
  - B. The FCC.
  - C. The station licensee only.
  - D. The owner of the property where the station is located.
  - E. The station licensee and any control operators.
17. Which of the following is **not** a station identification requirement?
- A. You must identify your station at the beginning of a transmission or a series of transmissions.
  - B. You must identify the other station at the beginning of a series of transmissions.
  - C. You must identify your station at 10 minute intervals.
  - D. You must identify the other station at the end of a series of transmissions.
  - E. You must identify your station at the end of a transmission or series of transmissions.
18. Which of the following is **not** an authorized type of one-way transmission?
- A. Information bulletins having direct interest to other stations.
  - B. Code practice.
  - C. Emergency communications.
  - D. Broadcasting.
  - E. Testing.

19. Select the true statement concerning a novice license.
- A. The applicant cannot hold any amateur radio license or be a representative of a foreign government.
  - B. The applicant must also hold some other class of amateur radio license.
  - C. The applicant does not need to take the code or written tests if he has held an amateur radio license in the past.
  - D. The applicant must be at least 18 years old.
  - E. None of the above.
20. Which of the following may obtain an amateur radio **station** license?
- A. Only a representative of the FCC.
  - B. Any citizens band licensee.
  - C. A licensed amateur radio operator.
  - D. Only a first-class or second-class radiotelephone licensee.
  - E. Anyone who is a citizen of the United States.
21. Which of the following is the best definition of a log?
- A. A record of the station's activity.
  - B. A list of authorized operating frequencies.
  - C. A list of the station's equipment.
  - D. A list of authorized operators.
  - E. None of the above.
22. Which of the following is **not** required in a log?
- A. The fixed location of the station.
  - B. The call sign of each station worked.
  - C. The date when the station began operation.
  - D. The call sign of the station.
  - E. The signature of the station licensee.
23. How long must you retain your station log after the last entry?
- A. Five years.
  - B. Six months.
  - C. Two years.
  - D. Indefinitely.
  - E. One year.

24. Which of the following is an acceptable transmitter frequency-measuring device?
- A. A dip meter.
  - B. A frequency counter.
  - C. A heterodyne frequency meter.
  - D. A calibrated receiver.
  - E. All of the above.
25. Which of the following may an amateur radio station communicate with?
- A. Only amateur stations with the same class of license.
  - B. Any amateur radio station.
  - C. A citizens band station.
  - D. Only amateur operators with a higher class of license.
  - E. Only amateur stations in the United States.
26. How long do you have to answer a Notice of Violation?
- A. Ten hours.
  - B. Two weeks.
  - C. One month.
  - D. Ten days.
  - E. One day.
27. When may the FCC restrict the operation of an amateur radio station?
- A. Any time.
  - B. Only on weekends.
  - C. Only during the nighttime.
  - D. Only during the daytime.
  - E. Never.
28. Which of the following is prohibited?
- A. Unidentified communications.
  - B. Willful interference.
  - C. Broadcasting.
  - D. Transmission of obscenity, indecency, or profanity.
  - E. All of the above.

29. When is international third-party traffic allowed?
- A. It is always allowed.
  - B. It is not allowed unless both countries consent to it.
  - C. It is not allowed unless one of the countries consents to it.
  - D. It is never allowed.
  - E. It is only allowed for business purposes.
30. Which of the following is **not** considered when the FCC modifies a license?
- A. The length of time the station was licensed.
  - B. Convenience.
  - C. Public interest.
  - D. Necessity.
  - E. None of the above.
31. Which of the following must you have with you when you operate any amateur radio station?
- A. Your original operator's license.
  - B. A copy of your station license.
  - C. Either a copy or the original operator's license.
  - D. A copy of the operator's license.
  - E. The original station license.
32. Which of the following must be posted at your station when it is operated by another amateur in your absence?
- A. The original operator's license only.
  - B. The visiting amateur's station license.
  - C. Either the original or a copy of the station license.
  - D. A copy of the visitor's operator's license.
  - E. The original station license.



**PRETEST ANSWERS**

<u>Q</u>	<u>A</u>	<u>Frame No.</u>
1.	D	(1)
2.	C	(2)
3.	D	(4)
4.	B	(7)
5.	B	(10)
6.	A	(13)
7.	E	(16)
8.	C	(19)
9.	E	(22)
10.	A	(25)
11.	D	(28)
12.	A	(31)
13.	D	(34)
14.	■ D	(38)
15.	A	(41)
16.	E	(44)
17.	B	(47)
18.	D	(50)
19.	A	(53)
20.	C	(56)
21.	A	(59)
22.	B	(62)
23.	E	(65)
24.	E	(68)
25.	B	(71)
26.	D	(74)
27.	A	(77)
28.	E	(80)
29.	B	(83)
30.	A	(86)
31.	A	(89)
32.	C	(92)

## INTRODUCTION

This module will teach you the basic rules and regulations that you must know before you operate an amateur radio transmitter. The main purpose of the rules and regulations is to prevent interference between different radio services and stations.

Several years ago, the International Telecommunication Union (ITU) was organized to help prevent interference between stations in different countries. This organization allocates blocks of frequencies to be used by the different services (broadcast, TV, amateur, etc.).

Most countries have their own governmental agency that controls radio transmitters within their boundaries. In the United States, the Communications Act of 1934 gives the Federal Communications Commission (FCC) the power to enact and enforce radio laws.

The radio laws, called the Rules and Regulations, are broken down into about 40 different groups. Each group, called a "Part," covers a different radio service. The Part which regulates the Amateur Radio Service is called Part 97. The basic regulations in Part 97 will be discussed in this module.

## PROGRAMMED INSTRUCTION

1. Shortly after the advent of radio, many experimenters who were fascinated by the mystery of radio began building simple transmitters and receivers. By the early 1900's, there were hundreds of "amateurs" in the United States.

Amateur radio soon proved its usefulness by providing communications during emergencies, helping improve commercial communications through its experiments, and improving international friendships.

**Although the amateur radio service has many purposes for its existence, the three main purposes are:**

1. To provide a voluntary, non-commercial communication service for the public that is especially useful during an emergency.
2. To advance the state of the art.
3. To create a reservoir of trained radio operators and electronics experts.

The three main purposes for the existence of the amateur radio service are:

1. To \_\_\_\_\_ the state of the art.
2. To create a reservoir of \_\_\_\_\_ radio operators and \_\_\_\_\_ experts.
3. To provide a \_\_\_\_\_, non-\_\_\_\_\_ communication service for the public that is especially useful during an emergency.

advance, trained, electronics, voluntary, commercial

2. Amateur radio allows you to learn about electronics at your own speed and to whatever depth you desire. You will also be able to experiment with new circuits and ideas.

As a radio operator, you will be able to communicate with other radio operators both near and far. It is not uncommon for radio operators to talk to someone as far away as Japan, India, or even Russia.

**The amateur radio service is a radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.**

The amateur radio service is a radio communication service of \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ carried on by amateur radio operators.

self-training, intercommunication, technical investigation

3. Select the three main purposes for the existence of the amateur radio service.

- A. To advance the state of the art.
- B. To provide a voluntary, commercial communication service for the public that is especially useful during an emergency.
- C. To allow intercommunication for the enjoyment of individuals.
- D. To create a reservoir of trained radio operators and electronics experts.
- E. To provide a voluntary, non-commercial communication service for the public that is especially useful during an emergency.

A, D, and E

4. A person of any age or profession can become an amateur or "ham" radio operator. Boys and girls less than 10 years of age and men and women over 80 have become hams. As a ham, you may talk to a doctor, a student, or even the king of some far away country.

**An amateur radio operator is any person interested in radio technique solely with a personal aim, and without pecuniary (monetary) interest, holding a valid Federal Communication Commission license to operate amateur radio stations.**

An amateur radio operator is \_\_\_\_\_ interested in radio technique solely with a personal aim, and without any \_\_\_\_\_ interest, holding a valid FCC \_\_\_\_\_ to operate amateur radio stations.

any person, pecuniary, license

5. Select the best definition of the amateur radio service.
- A. The amateur radio service is a radio communication service of self-training, intercommunication, and non-technical investigation carried on by amateur radio operators.
  - B. The amateur radio service is a radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.
  - C. The amateur radio service is a group of people interested in communicating with other people.
  - D. The amateur radio service is a radio communication service provided for business purposes.
  - E. None of the above.



6. Which of the following is **not** one of the three main purposes for the existence of the amateur radio service.

- A. To create a reservoir of trained radio operators and electronics experts.
- B. To provide a voluntary non-commercial communication service for the public that is especially useful during an emergency.
- C. To advance the state of the art.
- D. To provide a voluntary, commercial communication service for the public that is especially useful during an emergency.
- E. All of the above.

D

7. An amateur station consists of anything from a simple homemade transmitter and receiver to an elaborate transceiver with digital frequency display. Some ham stations have amateur television capability.

**An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communication.**

An amateur radio station is a station \_\_\_\_\_ in the amateur radio service embracing necessary \_\_\_\_\_ at a particular location used for \_\_\_\_\_ communication.

licensed, apparatus, amateur radio

8. Select the best definition of an amateur radio operator.

- A. An amateur radio operator is any person interested in radio technique solely with a commercial aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.
- B. An amateur radio operator is any person interested in radio technique solely with a personal aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.
- C. An amateur radio operator is a person who operates any radio station.
- D. An amateur radio operator is any person who uses a radio for business.
- E. An amateur radio operator is a telegraph operator.

9. Select the best definition of the amateur radio service.

- A. The amateur radio service is a radio communication service of self-training, intercommunication, and non-technical investigation carried on by amateur radio operators.
- B. The amateur radio service is a group of people interested in communicating with other people.
- C. The amateur radio service is a radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.
- D. The amateur radio service is a radio communication service provided for business purposes.
- E. None of the above.

10. The licensee of an amateur station is responsible for all operation from his station. If there are several operators using one station, such as a club station, all operators are responsible for the station's operation.

**A control operator is the licensee of an amateur radio station or some other operator designated by the licensee of the station to be responsible for the emissions from that station.**

A control operator is the \_\_\_\_\_ of an amateur radio station or some other \_\_\_\_\_ designated by the licensee of the station to be responsible for the emissions from that station.

licensee, operator

11. Select the best definition of an amateur radio station.

- A. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communications.
- B. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for broadcast communications.
- C. An amateur radio station is any licensed radio station.
- D. An amateur radio station is a station that consists only of home-built equipment.
- E. None of the above.

12. Select the best definition of an amateur radio operator.

- A. An amateur radio operator is any person who uses a radio for business.
- B. An amateur radio operator is a telegraph operator.
- C. An amateur radio operator is a person who operates a radio station.
- D. An amateur radio operator is any person interested in radio technique solely with a personal aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.
- E. An amateur radio operator is any person interested in radio technique solely with a commercial aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.

D

13. A station license is required before you can operate an amateur radio station from a given location. The station license is actually on the same piece of paper as the operator license.

**The station license is the instrument of authorization for a radio station in the amateur radio service.**

The station license is the \_\_\_\_\_ of \_\_\_\_\_ for a radio station in the amateur radio service.

instrument, authorization.

14. Select the best definition of a control operator.

- A. The control operator is the licensee of an amateur radio station or some other operator designated by the licensee of the station to be responsible for the emissions from that station.
- B. A control operator can only be the licensee of an amateur radio station.
- C. A representative from the FCC is the control operator of an amateur station.
- D. A control operator is any operator, other than the licensee, who uses an amateur radio station.
- E. The control operator is the person who owns the property where the equipment is located.

A

15. Select the best definition of an amateur radio station.

- A. An amateur radio station is any licensed radio station.
- B. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communications.
- C. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for broadcast communications.
- D. An amateur radio station is a station that consists only of home-built equipment.
- E. None of the above.

B



16. As an amateur radio operator, you may have as many stations as you wish. You could, for example, install a station in your home, your car, or even carry one with you.

**A primary station is the principal amateur radio station at a specific land location shown on the station license.**

A primary station is the \_\_\_\_\_ amateur radio station at a specific \_\_\_\_\_ location shown on the \_\_\_\_\_ license.

principal, land, station

17. Select the best definition of a station license.

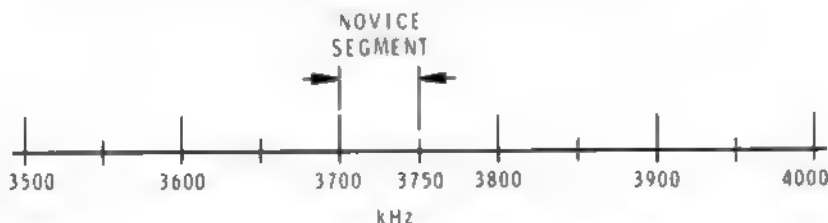
- A. A station license is the instrument of authorization that includes only the class of operator privileges.
- B. A station license is the instrument of authorization that includes only the call sign of the station.
- C. A station license is the instrument of authorization for a radio station in the amateur radio service.
- D. A station license is the instrument of authorization that includes only the location of a particular station.
- E. None of the above.

18. Select the best definition of a control operator.

- A. A control operator can only be the licensee of an amateur radio station.
- B. The control operator is the licensee of an amateur radio station or some other operator designated by the licensee of the station to be responsible for the emissions from that station.
- C. A control operator is any operator, other than the licensee, who uses an amateur radio station.
- D. The control operator of an amateur radio station is a representative of the FCC.
- E. A control operator is the person who owns the property where the amateur radio station is located.

B

19. The frequency band between 3500 and 4000 kHz (or 3.500 to 4.000 MHz) is referred to as the 80-meter amateur band.



80-METER AMATEUR BAND

On the 80-meter band, a novice may operate between 3700 and 3750 kHz (or 3.700 and 3.750 MHz).

A novice may operate between \_\_\_\_\_ and \_\_\_\_\_ kHz on the 80-meter band.

3700, 3750

20. Select the best definition of a primary station.

- A. A primary station is the amateur radio station you operate the most.
- B. A primary station is the amateur radio station that operates at full power.
- C. A primary station is the principal amateur radio station at a specific land location shown on the station license.
- D. A primary station is any land-based station.
- E. A primary station is any station owned and operated by an extra-class licensee.

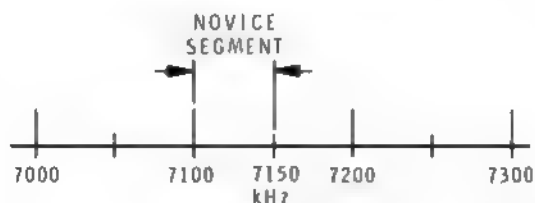
C

21. Select the best definition of a station license.

- A. A station license is the instrument of authorization for a radio station in the amateur radio service.
- B. A station license is the instrument of authorization that includes only the location of a particular station.
- C. A station license is the instrument of authorization that includes only the call sign of the station.
- D. A station license is the instrument of authorization that includes only the class of operator privileges.
- E. None of the above.

A

22. The frequency band between 7000 and 7300 kHz (7.000 and 7.300 MHz) is called the 40-meter amateur band.



40-METER AMATEUR BAND

On the 40-meter band, a novice may operate between 7100 and 7150 kHz (7.100 and 7.150 MHz).

A novice may operate between \_\_\_\_\_ and \_\_\_\_\_ kHz on the 40-meter band.

7100, 7150

23. Select the frequencies within the 80-meter amateur band where a novice may operate.

- A. 3750 — 3800 kHz.
- B. 7100 — 7150 kHz.
- C. 7.1 — 7.15 MHz.
- D. 3.7 — 3.75 MHz.
- E. None of the above.

D

24. Select the best definition of a primary station.

- A. A primary station is a station owned and operated by an extra-class licensee.
- B. A primary station is any land-based amateur radio station.
- C. A primary station is any amateur radio station that operates at full power.
- D. A primary station is the amateur radio station you operate the most.
- E. A primary station is the principal amateur radio station at a fixed land location shown on the station license.

1.

25. The frequency band between 21,000 and 21,450 kHz (21.000 and 21.450 MHz) is called the 15-meter band .



15-METER AMATEUR BAND

**On the 15-meter band, a novice may operate between 21,100 and 21,200 kHz (21.100 and 21.200 MHz).**

A novice may operate between \_\_\_\_\_ and \_\_\_\_\_ kHz on the 15-meter band.

21,100 and 21,200



26. Select the frequencies within the 40-meter amateur band where a novice may operate.

- A. 7100 — 7150 kHz.
- B. 7150 — 7200 kHz.
- C. 7050 — 7100 kHz.
- D. 3700 — 3750 kHz.
- E. 3.700 — 3.750 MHz.

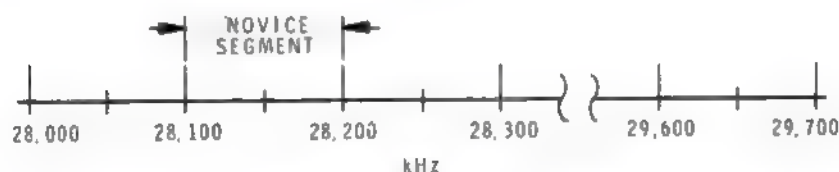
A

27. Select the frequencies within the 80-meter amateur band where a novice may operate.

- A. 7100 — 7150 kHz.
- B. 3700 — 3750 MHz.
- C. 3700 — 3750 kHz.
- D. 7.100 — 7.150 MHz.
- E. 7.100 — 7.150 kHz.

C

28. The frequency band between 28,000 and 29,700 kHz (28.000 and 29.700 MHz) is called the 10-meter amateur band (see Figure 1-4).



10-METER AMATEUR BAND

On the 10-meter band, a novice may operate between 28,100 and 28,200 kHz (28.100 and 28.200 MHz).

A novice may operate between \_\_\_\_\_ and \_\_\_\_\_ kHz on the 10-meter band.

28,100 and 28,200

29. Select the frequencies within the 15-meter amateur band where a novice may operate.

- A. 7100 — 7150 kHz.
- B. 3.7 — 3.75 MHz.
- C. 21.1 — 21.2 MHz.
- D. 21,150 — 21,250 kHz.
- E. 21.1 — 21.2 kHz.

30. Select the frequencies within the 40-meter amateur band where a novice may operate.

- A. 28.1 — 28.2 MHz.
- B. 21.1 — 21.2 MHz.
- C. 7.1 — 7.15 kHz.
- D. 3.7 — 3.75 MHz.
- E. 7.1 — 7.15 MHz.

31. There are several different types of emission that amateur radio operators are permitted to use.

**A novice may use only type A1 emission.**

Type A1 emission means telegraphy (International Morse Code) on pure continuous waves. This is commonly referred to by amateur radio operators as "CW," which is the abbreviation for continuous wave.

A novice may use only type \_\_\_\_\_ emission.

32. Select the frequencies within the 10-meter amateur band where a novice may operate.

- A. 3700 — 3750 kHz.
- B. 28.1 — 28.2 MHz.
- C. 28.200 — 28.300 MHz.
- D. 7100 — 7150 kHz.
- E. 21.100 — 21.200 MHz.

B

33. Select the frequencies within the 15-meter amateur band where a novice may operate.

- A. 21,100 — 21,200 kHz.
- B. 21,100 — 21,200 MHz.
- C. 21.100 — 21.200 kHz.
- D. 21,000 — 21,100 kHz.
- E. None of the above.

A

34. All amateur radio operators have a maximum permitted transmitter power level. This power is measured at the **input** to the transmitter final amplifier stage that supplies RF (radio frequency) energy to the antenna. This power does not include the power used to heat the cathodes of the vacuum tubes (on transmitters that have tubes).

**The maximum transmitter power a novice may use is 250 watts input.**

No matter how much maximum power your license allows you to use, the FCC requires that you use the **minimum** amount of power necessary to communicate with a given station.

A novice may use a maximum of \_\_\_\_\_ watts input.

250

35. Select the type of emission that a novice may use.

- A. A $\phi$ .
- B. A1.
- C. A2.
- D. A3.
- E. F1.

B

36. Select the frequencies within the 10-meter amateur band where a novice may operate.

- A. 21,100 — 21,200 MHz.
- B. 21,100 — 21,200 kHz.
- C. 28,100 — 28,200 MHz.
- D. 28,100 — 28,200 kHz.
- E. 21.1 — 21.2 MHz.

D

37. Select the band or bands where a novice may operate.

- A. 3700 — 3750 kHz.
- B. 7100 — 7150 kHz.
- C. 21.1 — 21.2 MHz.
- D. 28.1 — 28.2 MHz.
- E. All of the above.

E

38. All classes of amateur radio licenses, except novice, are good for five years and are renewable.

The novice class license is only good for **5 YEARS** and is **renewable**.

When the novice license expires, you may take the test over again and obtain a new novice license, which is good for another two years.

The novice class license is good for \_\_\_\_\_ years and is \_\_\_\_\_ renewable.

two, not

39. Select the maximum transmitter power a novice may use.

- A. 1000 watts output.
- B. 1000 watts input.
- C. 250 watts output.
- D. 250 watts input.
- E. 100 watts input.

D

40. Select the type of emission a novice may use.

- A. A1.
- B. A $\phi$ .
- C. F1.
- D. F2.
- E. A3.

A

41. Most amateur radio operators have antennas less than 200 feet above ground and are not affected by the Rules and Regulations concerning antenna structure.

**An antenna structure may be one foot above ground for each 100 feet the structure is from the nearest boundary of an airport.**

You may exceed the restrictions in the above statement if the structure is less than 20 feet above another existing structure such as a tree, building, etc.

How high may you construct an antenna if you live 2 miles from an airport?

**SOLUTION:**

$$\begin{aligned} 2 \text{ miles} &= 10,560 \text{ feet } (5,280 \text{ feet/mile} \times 2) \\ 10,560 &\div 100 = 105.6 \text{ feet (answer)} \end{aligned}$$

How high may you construct an antenna if you live 3 miles from an airport? \_\_\_\_\_.

$$158.4 \text{ feet } \left( \frac{5,280 \text{ feet} \times 3 \text{ miles}}{100} = 158.4 \text{ feet} \right)$$

42. Which of the following is true concerning a novice license?

- A. License is good for 2 years, renewable.
- B. License is good for one year, non-renewable.
- C. License is good for one year, renewable.
- D. License is good for five years, renewable.
- E. License is good for two years, non-renewable.

43. Select the maximum transmitter power a novice is permitted to use.

- A. 1000 watts output.
- B. 250 watts output.
- C. 1000 watts input.
- D. 250 watts input.
- E. 100 watts input.

D

44. An amateur station may be operated by the station licensee designated by the station license.

**The station licensee and each control operator, if any, is responsible for proper operation of an amateur radio station.**

The station \_\_\_\_\_ and each \_\_\_\_\_, if any, is responsible for the proper operation of an amateur radio station.

licensee, control operator

45. What is the maximum height above ground you may construct an antenna structure if you live one mile from an airport?

- A. 105 feet.
- B. 52.8 feet.
- C. 200 feet.
- D. 52 yards.
- E. None of the above.

B (5,280 feet/mile divided by 100)



46. Which of the following is the correct term of a novice license?

- A. License is good for five years, renewable.
- B. License is good for one year, renewable.
- C. License is good for two years, non-renewable.
- D. License is good for one year, non-renewable.
- E. License is good for two years, renewable.

■ A

47. Every amateur radio operator in the world is assigned call letters by his government. The first part of the call letters, usually one or two letters, indicate which country the station is licensed in. The number after the first letter(s) indicate a smaller area within that country. For example, in the call sign K8XYZ, the K indicates the station is in the United States and the 8 indicates it is in Michigan, Ohio, or West Virginia. The rest of the call sign (XYZ) is assigned randomly.

**You must identify your station at the beginning and end of a transmission, or series of transmissions, and at intervals not to exceed 10 minutes.**

In addition to identifying your station, you must identify the stations (if more than one), with whom you are talking at the end of a transmission or series of transmissions.

You must identify your station at the \_\_\_\_\_ and \_\_\_\_\_ of a transmission, or series of transmissions, and at intervals not to exceed \_\_\_\_\_ minutes.

beginning, end, 10

48. Which of the following is responsible for the proper operation of an amateur radio station?

- A. The station licensee only.
- B. The station licensee and any control operators.
- C. The station control operators only.
- D. The FCC.
- E. The owner of the property where the station is located.

B

49. Select the maximum height you may construct an antenna structure if you live 2-1/2 miles from an airport.

- A. 132 feet.
- B. 13.2 feet.
- C. 132 yards.
- D. 52 feet.
- E. 200 feet.

A (  $\frac{5,280 \text{ feet} \times 2.5 \text{ miles}}{100} = 132$  )

50. An amateur radio station may transmit one-way signals for testing, emergency communications (including drill practice), information bulletins having direct interest to amateur radio operators, round table (group) discussions, and code practice.

**An amateur radio station may not be used for any form of broadcasting either directly or indirectly, to the public.**

An amateur radio station may not be used for any form of \_\_\_\_\_, either directly or indirectly, to the public.

broadcasting

**51. Which of the following is *not* a station identification requirement:**

- A. You must identify your station at the beginning of a transmission or series of transmissions.
- B. You must identify your station at the end of a transmission or series of transmissions.
- C. You must identify your station at 10-minute intervals.
- D. You must identify the other station at the end of a series of transmissions.
- E. You must identify the other station at the beginning of a series of transmissions.

E

**52. Which of the following is responsible for the proper operation of an amateur radio station?**

- A. The control operator(s) only.
- B. The FCC.
- C. The station licensee only.
- D. The owner of the property where the station is located.
- E. The station licensee and any control operators.

F

**53. Anyone who does not hold an amateur radio license and is not a representative of a foreign government is eligible for a novice license.**

Until recently, you had to wait a year after the expiration of a novice license before you could reapply for a new novice license. Now, you can reapply for a novice license as soon as it expires, but you must pass the code and written tests again.

Anyone who does not hold an \_\_\_\_\_ radio license and is not a representative of a \_\_\_\_\_ government is eligible for a novice license.

amateur, foreign

54. Which of the following is **not** an authorized type of one-way transmission?

- A. Information bulletins having direct interest to other amateurs.
- B. Code practice.
- C. Emergency communications.
- D. Broadcasting.
- E. Testing.

D

55. Which of the following is a station identification requirement?

- A. You must identify your station at the beginning of a transmission or series of transmissions.
- B. You must identify your station at the end of a transmission or series of transmissions.
- C. You must identify your station at 10-minute intervals.
- D. You must identify the other station at the end of a transmission or series of transmissions.
- E. All of the above.

E

56. Except for a military amateur station license, only a licensed amateur radio operator can obtain an amateur radio station license.

In most cases, both the station license and the operator license are printed on the same form. The station license authorizes the installation of a station at a given location. An operator license authorizes an individual to operate an amateur radio station.

Except for a military amateur station license, only a \_\_\_\_\_ amateur radio \_\_\_\_\_ can obtain an amateur radio station license.

licensed, operator

57. Which of the following is a true statement concerning a novice license?

- A. The applicant must be at least 18 years old.
- B. The applicant must hold some other class of amateur radio license.
- C. The applicant does not need to take the code and written tests if he has successfully passed them at some earlier date.
- D. The applicant cannot hold any amateur radio license or be a representative of a foreign government.
- E. None of the above.

D

58. Which of the following is **not** an authorized type of one-way transmission?

- A. Information bulletins having direct interest to other amateurs.
- B. Broadcasting.
- C. Emergency communications.
- D. Testing.
- E. Code practice.

B

59. Many amateur radio operators keep very complete written notes on all transmissions they make from their stations.

**A written record of an amateur radio station's activity is called a log.**

A written record of an amateur radio station's activity is called a \_\_\_\_\_.

log

60. Who may obtain an amateur radio **station** license?

- A. Anyone who is a citizen of the United States.
- B. A licensed amateur radio operator.
- C. An unlicensed amateur radio operator.
- D. Any citizens band licensee.
- E. Only a person designated by the FCC.

B

61. Select the true statement concerning a novice license.

- A. The applicant cannot hold any amateur radio license or be a representative of a foreign government.
- B. The applicant must also hold some other class of amateur radio license.
- C. The applicant does not need to take the code or written tests if he has held an amateur radio license in the past.
- D. The applicant must be at least 18 years old.
- E. None of the above.

A

- 62.** Until recently, the FCC required an amateur operator to keep complete up-to-date logs of his station activities. In 1974 the logging requirements were significantly reduced to the minimum we now have.

**The minimum contents required in a log are:**

- 1. The station call letters and the signature of the station licensee (or a photocopy of the station license).**
- 2. The locations and dates upon which fixed operation of the station was initiated and terminated.**
- 3. The primary call sign of any control operator and the dates and times he operated the station.**

In addition to the above required log contents, the FCC may require other information in a particular station's log.

**The minimum contents required in a log are:**

- 1. The station \_\_\_\_\_ and the \_\_\_\_\_ of the station licensee.**
- 2. The locations and dates when fixed operation was \_\_\_\_\_ and \_\_\_\_\_.**
- 3. The primary \_\_\_\_\_ of any control operator and the dates and times he operated the station.**

- 1 call letters, signature**
- 2 initiated, terminated**
- 3 call letters**



**63.** Which of the following best describes an amateur radio station log?

- A. A list of authorized operators.
- B. A list of the station's equipment.
- C. A list of the authorized operating frequencies.
- D. A record of the station's activity.
- E. None of the above.

D

**64.** Which of the following may obtain an amateur radio station license?

- A. Only a representative of the FCC.
- B. Any citizens band licensee.
- C. A licensed amateur radio operator.
- D. Only a first-class or second-class radiotelephone licensee.
- E. Anyone who is a citizen of the United States.

C

**65.** A station log must be kept for at least one year after the date of the last entry.

A station log must be kept for at least \_\_\_\_\_ after the date of the last entry.

one year



66. Which of the following is **not** required in a log?

- A. The call sign of the station.
- B. The signature of the station licensee.
- C. The fixed location of the station.
- D. The date when the station began operation.
- E. The frequency of each operation.

F

67. Select the best definition of a station log.

- A. A record of the station's activity.
- B. A list of authorized operating frequencies.
- C. A list of the station's equipment.
- D. A list of the authorized operators.
- E. None of the above.

A

68. The FCC requires you to make regular checks of your transmitter frequency. This will ensure you that your transmitter dial is calibrated accurately and you will be operating in the proper amateur band. The method you use must be independent of the means used to control the transmitter frequency. This means, you cannot simply read the dial on your transmitter.

**Some acceptable frequency-measuring devices are: a frequency counter, a calibrated receiver, a heterodyne frequency meter, or a dip meter.**

Four acceptable frequency-measuring devices are: a \_\_\_\_\_, a \_\_\_\_\_, a \_\_\_\_\_, or a \_\_\_\_\_.

frequency counter, calibrated receiver, heterodyne frequency meter, dip meter.

69. How long must you retain your log after the last entry?

- A. One year.
- B. Two years.
- C. Five years.
- D. Indefinitely.
- E. Six months.

A

70. Which of the following is **not** required in a log?

- A. The fixed location of the station.
- B. The call sign of each station worked.
- C. The date when the station began operation.
- D. The call sign of the station.
- E. The signature of the station licensee.

B

71. An amateur radio station may communicate with other amateur stations or any station authorized by the FCC to communicate with amateurs.

An amateur radio station may communicate with other \_\_\_\_\_ or any \_\_\_\_\_ authorized by the FCC to communicate with amateurs.

amateur stations, station

72. Which of the following is **not** an acceptable transmitter frequency-measuring device?

- A. A heterodyne frequency meter.
- B. A calibrated receiver.
- C. A frequency counter.
- D. The transmitter tuning dial.
- E. A dip meter.

D

73. How long must you retain your station log after the last entry?

- A. Five years.
- B. Six months.
- C. Two years.
- D. Indefinitely.
- E. One year.

E

74. Although most amateurs strive to operate within the Rules and Regulations, occasionally a rule is accidentally broken. If one of the FCC's monitoring stations hears a violation, they may send the station at fault a Notice of Violation. Usually all that is required is a prompt reply stating you will take action to prevent a recurrence.

**You must reply to a Notice of Violation within 10 days.**

The worst thing you can do is ignore a Notice of Violation. The FCC could suspend or revoke your license or even levy a fine.

You must reply to a Notice of Violation within \_\_\_\_\_ days.

75. Which of the following is an amateur radio operator authorized to communicate with?

- A. A citizens band station.
- B. Only amateur stations with the same class of license.
- C. Any amateur radio station.
- D. Only amateur operators with a higher class of license.
- E. Only amateur stations in the United States.

C

76. Which of the following is an acceptable transmitter frequency-measuring device.

- A. A dip meter.
- B. A frequency counter.
- C. A heterodyne frequency meter.
- D. A calibrated receiver.
- E. All of the above.

E

77. Amateur radio operators may operate their stations at any time they desire and are not bound to any schedules.

**The FCC may restrict the operation of a particular station at any time.**

Usually the FCC restricts stations only when there is interference with broadcast services or when an operator fails to answer a Notice of Violation.

The FCC may restrict the operation of a station at

any time

78. How much time do you have to answer a Notice of Violation?

- A. Ten days
- B. Ten hours
- C. Two weeks.
- D. One month.
- E. One day.

A

79. Which of the following may an amateur radio station communicate with?

- A. Only amateur stations with the same class of license.
- B. Any amateur radio station.
- C. A citizens band station.
- D. Only amateur operators with a higher class of license.
- E. Only amateur stations in the United States.

B

80. Although there are very few restrictions as to what an amateur may talk about on his radio, there are a few things that are not permitted.

**An amateur radio operator may not engage in broadcasting, unidentified communications, or willful interference. Also, he cannot transmit obscenity, indecency, or profanity.**

An amateur radio operator may not engage in \_\_\_\_\_,  
\_\_\_\_\_, or \_\_\_\_\_. Also, he cannot transmit \_\_\_\_\_,  
\_\_\_\_\_, or \_\_\_\_\_.

broadcasting, unidentified communications, willful interference,  
obscenity, indecency, profanity.

81. When may the FCC restrict the operation of an amateur radio station?

- A. Only during the daytime.
- B. Only during the nighttime.
- C. Only on weekends.
- D. Any time.
- E. Never.

D

82. How much time do you have to answer a Notice of Violation?

- A. Ten hours.
- B. Two weeks.
- C. One month.
- D. Ten days.
- E. One day.

D

83. If an amateur radio operator provides communications or sends a message for another person, this is called "third party traffic."

**International third party traffic is not allowed unless the two countries involved consent to it.**

Any third party traffic that involves any kind of material compensation (payment) is prohibited.

International third party traffic is \_\_\_\_\_ unless  
(allowed/not allowed)  
the two countries involved consent to it.

not allowed

**84. Which of the following is prohibited?**

- A. Broadcasting.
- B. Unidentified communications.
- C. Willful interference.
- D. Transmission of obscenity, indecency, or profanity.
- E. All of the above.

E

**85. When may the FCC restrict the operation of an amateur radio station?**

- A. Any time.
- B. Only on weekends.
- C. Only during the nighttime.
- D. Only during the daytime.
- E. Never.

A

**86. The FCC may modify a station license any time it determines that public interest, convenience, and necessity would be served.**

Before the FCC modifies a station license, it orders the licensee to show cause why the station license should not be modified.

The FCC may modify a station license any time it determines that \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_ would be served.

public interest, convenience, necessity.



87. International third party traffic is . . . . .

- A. Never allowed.
- B. Not allowed unless one of the countries consents to it.
- C. Not allowed unless both countries consent to it.
- D. Always allowed.
- E. None of the above.

C

88. Which of the following is prohibited?

- A. Unidentified communications.
- B. Willful interference.
- C. Broadcasting.
- D. Transmission of obscenity, indecency, or profanity.
- E. All of the above.

E

89. A licensed radio amateur may operate his own station or the station of another amateur.

**You must always have your original operator's license with you any time you operate an amateur station.**

If you only operate your own station you may post your license at your station. If, however, you operate the station of a friend, you must have your original license with you.

You must always have your \_\_\_\_\_ operator's license with you any time you operate an amateur station.

original



90. Which of the following is **not** considered when the FCC modifies a station license?

- A. Necessity.
- B. The length of time the station was licensed.
- C. Public interest.
- D. Convenience.
- E. None of the above.

B

91. International third party traffic is . . . . .

- A. Always allowed.
- B. Not allowed unless both countries consent to it.
- C. Not allowed unless one of the countries consents to it.
- D. Never allowed.
- E. Only allowed for business purposes.

B

92. As explained earlier, you must have your original operator's license with you any time you operate an amateur station. This is not true in the case of the station license.

**It is only necessary to post a copy of the station license at your station.**

If you are the only person that operates your station, and since the operator's license and the station license is really the same piece of paper, all you need is the original license. If, however, another amateur radio operator uses your station in your absence, a copy of the station license (or the original) must be present.

It is only necessary to post \_\_\_\_\_ of the station license at your station.

a copy

93. Which of the following must you have with you when you operate any amateur radio station?

- A. A copy of your station license.
- B. Either a copy or the original operators license.
- C. A copy of the operator's license.
- D. Your original operator's license.
- E. The original station license.

D

94. Which of the following is **not** considered when the FCC modifies a license?

- A. The length of time the station was licensed.
- B. Convenience.
- C. Public interest.
- D. Necessity.
- E. None of the above.

A

95. Which of the following must be posted at your station when it is operated by another amateur in your absence?

- A. The original station license only.
- B. A copy of the visitor's operator's license.
- C. Either the original or a copy of the station license.
- D. The visiting amateur's station license.
- E. The original operator's license.

C

**96.** Which of the following must you have with you when you operate any amateur radio station?

- A. Your original operator's license.
- B. A copy of your station license.
- C. Either a copy or the original operator's license.
- D. A copy of the operator's license.
- E. The original station license.

A

**97.** Which of the following must be posted at your station when it is operated by another amateur in your absence?

- A. The original operator's license only.
- B. The visiting amateur's station license.
- C. Either the original or a copy of the station license.
- D. A copy of the visitor's operator's license.
- E. The original station license.

C

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than six questions, go back and re-read this whole module.
  - If you have less than six incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame). Then proceed to the next module.
1. Which of the following is **not** one of the main purposes for the existence of the amateur radio service?
    - A. To create a reservoir of trained radio operators and electronics experts.
    - B. To provide a voluntary, non-commercial communication service for the public that is especially useful during an emergency.
    - C. To advance the state of the art.
    - D. To provide a voluntary, commercial communication service for the public that is especially useful during an emergency.
    - E. All of the above.
  2. Select the best definition of the amateur radio service.
    - A. The amateur radio service is a radio communication service of self-training, intercommunication, and non-technical investigation carried on by amateur radio operators.
    - B. The amateur radio service is a group of people interested in communicating with other people.
    - C. The amateur radio service is a radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.
    - D. The amateur radio service is a radio communication service provided for business purposes.
    - E. None of the above.

3. Select the best definition of an amateur radio operator.
- A. An amateur radio operator is any person who uses a radio for business.
  - B. An amateur radio operator is a telegraph operator.
  - C. An amateur radio operator is a person who operates a radio station.
  - D. An amateur radio operator is any person interested in radio techniques solely with a personal aim, and without any pecuniary (monetary) interest, holding a valid FCC license to operate amateur radio stations.
  - E. An amateur radio operator is any person interested in radio technique solely with a commercial aim, and without any pecuniary interest, holding a valid FCC license to operate amateur radio stations.
4. Select the best definition of an amateur radio station.
- A. An amateur radio station is any licensed radio station.
  - B. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio station communications.
  - C. An amateur radio station is a station licensed in the amateur radio service embracing necessary apparatus at a particular location used for broadcasting communications.
  - D. An amateur radio station is a station that consists only of home-built equipment.
  - E. None of the above.
5. Select the best definition of a control operator.
- A. A control operator can only be the licensee of an amateur radio station.
  - B. A control operator can only be the licensee of an amateur radio station or some other operator designated by the licensee of the station to be responsible for the emissions from that station.
  - C. A control operator is any operator, other than the licensee, who uses an amateur radio station.
  - D. The control operator of an amateur radio station is a representative of the FCC.
  - E. A control operator is the person who owns the property where the amateur radio station is located.

6. Select the best definition of a station license.
- A. A station license is the instrument of authorization for a radio station in the amateur radio service.
  - B. A station license is the instrument of authorization that includes only the location of a particular station.
  - C. A station license is the instrument of authorization that includes only the call sign of the station.
  - D. A station license is the instrument of authorization that includes only the class of operator privileges.
  - E. None of the above.
7. Select the best definition of a primary station.
- A. A primary station is a station owned and operated by an extra-class licensee.
  - B. A primary station is any land-based amateur radio station.
  - C. A primary station is any amateur radio station that operates at full power.
  - D. A primary station is the amateur radio station you operate the most.
  - E. A primary station is the principal amateur radio station at a fixed land location shown on the station license.
8. Which of the following segments within the 80-meter band may a novice use?
- A. 7100 — 7150 kHz.
  - B. 3700 — 3750 MHz.
  - C. 3700 — 3750 kHz.
  - D. 7.100 — 7.150 MHz.
  - E. 7.100 — 7.150 kHz.
9. Which of the following segments within the 40-meter band is authorized for novice use?
- A. 28.1 — 28.2 MHz.
  - B. 21.1 — 21.2 MHz.
  - C. 7.1 — 7.15 kHz.
  - D. 3.7 — 3.75 MHz.
  - E. 7.1 — 7.15 MHz.

10. Which of the following segments within the 15-meter band may a novice use?
- A. 21,100 — 21,200 kHz.
  - B. 21,100 — 21,200 MHz.
  - C. 21.100 — 21.200 kHz.
  - D. 21,000 — 21,100 kHz.
  - E. None of the above.
11. Which of the following segments within the 10-meter band is authorized for novice use?
- A. 21,100 — 21,200 MHz.
  - B. 21,100 — 21,200 kHz.
  - C. 28,100 — 28,200 MHz.
  - D. 28,100 — 28,200 kHz.
  - E. 21.1 — 21.2 MHz.
12. What type of emission may a novice use?
- A. A1.
  - B. A $\phi$ .
  - C. C1.
  - D. F2.
  - E. A3.
13. What is the maximum power a novice may use?
- A. 1000 watts output.
  - B. 250 watts output.
  - C. 75 watts input.
  - D. 250 watts input.
  - E. 100 watts input.
14. Which of the following is true concerning a novice license?
- A. License is good for two years, renewable.
  - B. License is good for one year, non-renewable.
  - C. License is good for one year, renewable.
  - D. License is good for five years, renewable.
  - E. License is good for two years, non-renewable.

15. What is the maximum height you could construct an antenna if you live two miles from an airport?
- A. 105.6 feet.
  - B. 10.56 feet.
  - C. 105 yards.
  - D. 1056 feet.
  - E. 200 feet.
16. Which of the following is responsible for the proper operation of an amateur radio station?
- A. The control operator(s) only.
  - B. The FCC.
  - C. The station licensee only.
  - D. The owner of the property where the station is located.
  - E. The station licensee and any control operators.
17. Which of the following is **not** a station identification requirement?
- A. You must identify your station at the beginning of a transmission or a series of transmissions.
  - B. You must identify the other station at the beginning of a series of transmissions.
  - C. You must identify your station at 10 minute intervals.
  - D. You must identify the other station at the end of a series of transmissions.
  - E. You must identify your station at the end of a transmission or series of transmissions.
18. Which of the following is **not** an authorized type of one-way transmission?
- A. Information bulletins having direct interest to other stations.
  - B. Code practice.
  - C. Emergency communications.
  - D. Broadcasting.
  - E. Testing.



19. Select the true statement concerning a novice license.
- A. The applicant cannot hold any amateur radio license or be a representative of a foreign government.
  - B. The applicant must also hold some other class of amateur radio license.
  - C. The applicant does not need to take the code or written tests if he has held an amateur radio license in the past.
  - D. The applicant must be at least 18 years old.
  - E. None of the above.
20. Which of the following may obtain an amateur radio **station** license?
- A. Only a representative of the FCC.
  - B. Any citizens band licensee.
  - C. A licensed amateur radio operator.
  - D. Only a first-class or second-class radiotelephone licensee.
  - E. Anyone who is a citizen of the United States.
21. Which of the following is the best definition of a log?
- A. A record of the station's activity.
  - B. A list of authorized operating frequencies.
  - C. A list of the station's equipment.
  - D. A list of authorized operators.
  - E. None of the above.
22. Which of the following is **not** required in a log?
- A. The fixed location of the station.
  - B. The call sign of each station worked.
  - C. The date when the station began operation.
  - D. The call sign of the station.
  - E. The signature of the station licensee.
23. How long must you retain your station log after the last entry?
- A. Five years.
  - B. Six months.
  - C. Two years.
  - D. Indefinitely.
  - E. One year.

24. Which of the following is an acceptable transmitter frequency-measuring device?
- A. A dip meter.
  - B. A frequency counter.
  - C. A heterodyne frequency meter.
  - D. A calibrated receiver.
  - E. All of the above.
25. Which of the following may an amateur radio station communicate with?
- A. Only amateur stations with the same class license.
  - B. Any amateur radio station.
  - C. A citizens band station.
  - D. Only amateur operators with a higher class of license.
  - E. Only amateur stations in the United States.
26. How much time do you have to answer a Notice of Violation?
- A. Ten hours.
  - B. Two weeks.
  - C. One month.
  - D. Ten days.
  - E. One day.
27. When may the FCC restrict the operation of an amateur radio station?
- A. Any time.
  - B. Only on weekends.
  - C. Only during the nighttime.
  - D. Only during the daytime.
  - E. Never.
28. Which of the following is prohibited?
- A. Unidentified communications.
  - B. Willful interference.
  - C. Broadcasting.
  - D. Transmission of obscenity, indecency, or profanity.
  - E. All of the above.

29. When is international third-party traffic allowed?
- A. It is always allowed.
  - B. It is not allowed unless both countries consent to it.
  - C. It is not allowed unless one of the countries consents to it.
  - D. It is never allowed.
  - E. It is only allowed for business purposes.
30. Which of the following is **not** considered when the FCC modifies a license?
- A. The length of time the station was licensed.
  - B. Convenience.
  - C. Public interest.
  - D. Necessity.
  - E. None of the above.
31. Which of the following must you have with you when you operate any amateur radio station?
- A. Your original operator's license.
  - B. A copy of your station license.
  - C. Either a copy or the original operator's license.
  - D. A copy of the operator's license.
  - E. The original station license.
32. Which of the following must be posted at your station when it is operated by another amateur in your absence?
- A. The original operator's license only.
  - B. The visiting amateur's station license.
  - C. Either the original or a copy of the station license.
  - D. A copy of the visitor's operator's license.
  - E. The original station license.



**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>Frame No.</u>
1.	D	(1)
2.	C	(2)
3.	D	(4)
4.	B	(7)
5.	B	(10)
6.	A	(13)
7.	E	(16)
8.	C	(19)
9.	E	(22)
10.	A	(25)
11.	D	(28)
12.	A	(31)
13.	D	(34)
14.	D	(38)
15.	A	(41)
16.	E	(44)
17.	B	(47)
18.	D	(50)
19.	A	(53)
20.	C	(56)
21.	A	(59)
22.	B	(62)
23.	E	(65)
24.	E	(68)
25.	B	(71)
26.	D	(74)
27.	A	(77)
28.	E	(80)
29.	B	(83)
30.	A	(86)
31.	A	(89)
32.	C	(92)





**Individual Learning Program**

**In**

**AMATEUR RADIO**

**(NOVICE LICENSE)**

**2**

**RADIO  
PHENOMENA**







# Individual Learning Program

## AMATEUR RADIO (NOVICE LICENSE)

### *Module 2* RADIO PHENOMENA ER-3701

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BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When you complete this Module, you will be able to select:

1. The definition of "ionosphere."
2. The definition of "ground wave."
3. The definition of "sky wave."
4. The definition of "skip distance."
5. The definition of "skip zone."
6. The definition of "sunspot cycle."
7. The relationship between hertz, kilohertz, and megahertz.
8. What the length in meters of one cycle of a radio wave is called.
9. The amateur bands that give the best range during the daytime.
10. The amateur bands that are most reliable during the nighttime.
11. The amateur bands that give the most distance during the summer months.
12. The amateur bands that give the best distance during the winter months.
13. The velocity of a radio wave in space.
14. The wavelength of a radio wave when you are given the frequency.
15. The frequency of a radio wave when you are given the wavelength.
16. The part of the radio spectrum that gives long-range communications by way of the ionosphere.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare the answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than three questions, read this whole module.
- If you have less than three incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parenthesis, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the next module.

1. What is the layer of ionized gases above the earth called?

- A. The 50-mile layer.
- B. The troposphere.
- C. The radio region.
- D. The ionosphere.
- E. The atmosphere.

2. What is the radio wave that travels along the ground called?

- A. A sky wave.
- B. An earth wave.
- C. A neutral wave.
- D. A surface wave.
- E. A ground wave.

3. What is a radio wave that travels upward, is bent by the ionosphere, and returns to the earth called?

- A. A ground wave.
- B. A sky wave.
- C. A bounce wave.
- D. A refracting wave.
- E. An atmospheric wave.

4. What is the distance between the transmitter and the first bounce of the sky wave called?
  - A. The skip distance.
  - B. The ground wave distance.
  - C. The skip zone.
  - D. The bounce distance.
  - E. The transmitter's maximum range.
5. What is the distance between the ground wave range and the point where the sky wave first strikes the earth called?
  - A. The skip distance.
  - B. The strike distance.
  - C. The skip zone.
  - D. The ground wave distance.
  - E. The bounce difference.
6. What is the 11-year cycle which causes changes in the layers of the ionosphere called?
  - A. The atmospheric cycle.
  - B. The sunspot cycle.
  - C. The wavelength.
  - D. The 11-year cycle.
  - E. The ionospheric cycle.
7. What is the frequency 7150 kHz in MHz?
  - A. 7.15 MHz.
  - B. 71.5 MHz.
  - C. 715 MHz.
  - D. 40 MHz
  - E. .715 MHz.
8. What is the length in meters of one cycle of a radio wave called?
  - A. Kilohertz.
  - B. Megahertz.
  - C. Hertz.
  - D. Wavelength.
  - E. All of the above.

9. Which amateur bands give the best results during the daytime?
- A. The 15- and 10-meter bands.
  - B. The 15- and 10-megahertz bands.
  - C. The 80- and 40-meter bands.
  - D. The 80- and 40-megahertz bands.
  - E. The 80- and 40-kilohertz bands.
10. Which amateur bands give the best results during the nighttime?
- A. The 15- and 10-meter bands.
  - B. The 80- and 40-meter bands.
  - C. The 80- and 40-megahertz bands.
  - D. The 15- and 10-megahertz bands.
  - E. The 80- and 40-kilohertz bands.
11. Which amateur bands give the best distance during the summer months?
- A. The 15- and 10-megahertz bands.
  - B. The 80- and 40-meter bands.
  - C. The 15- and 10-meter bands.
  - D. The 80- and 40-megahertz bands.
  - E. The 15- and 10-kilohertz bands.
12. Which amateur bands give the best distance during the winter months?
- A. The 15- and 10-meter bands.
  - B. The 80- and 40-kilohertz bands.
  - C. The 80- and 40-megahertz bands.
  - D. The 15- and 10-megahertz bands.
  - E. The 80- and 40-meter bands.
13. What is the velocity of a radio wave in space?
- A. 300,000,000 feet per second.
  - B. 300,000 meters per second.
  - C. 3,000 meters per second.
  - D. 300,000,000 meters per second.
  - E. 300 meters per second.

14. What is the wavelength of 15,000 kHz?
- A. 20 meters.
  - B. .2 meters.
  - C. 2 meters.
  - D. 200 meters.
  - E. 2000 meters.
15. What is the frequency of 40 meters?
- A. .75 megahertz.
  - B. 7500 megahertz.
  - C. 750 megahertz.
  - D. 7.5 megahertz.
  - E. 75 megahertz.
16. Long range communications by way of the ionosphere are generally limited to which part of the radio spectrum?
- A. The HF portion.
  - B. The UHF portion.
  - C. The microwave portion.
  - D. The VHF portion.
  - E. None of the above.

## PRETEST ANSWERS

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	A	(7)
5.	C	(10)
6.	B	(13)
7.	A	(16)
8.	D	(19)
9.	A	(22)
10.	B	(25)
11.	C	(28)
12.	E	(31)
13.	D	(34)
14.	A	(37)
15.	D	(40)
16.	A	(43)

## INTRODUCTION

Radio communication is not the same at all hours of the day or at all times of the year. Even though both radio waves and the atmosphere above the earth are invisible, the atmosphere plays an important role in radio communications. Things happening on the sun, even though it is about 93 million miles away, also have a direct effect on your communications. This module on "Radio Phenomena" will show you how the condition of the atmosphere affects radio communication.

## PROGRAMMED INSTRUCTION

1. About 50 miles above the earth is the beginning of a region made up of several layers of ionized gases. This region plays an important role in radio communication.

**The region of ionized gases above the earth is called the "ionosphere."**

Even though the ionosphere is made up of several layers, it is often referred to as a single layer.

The region of ionized gases above the earth is called the \_\_\_\_\_.

ionosphere

2. High frequency (HF) radio waves travel two (for all practical purposes) routes (see Figure 2-1). One route is along the ground, and the other is upward toward the ionosphere.

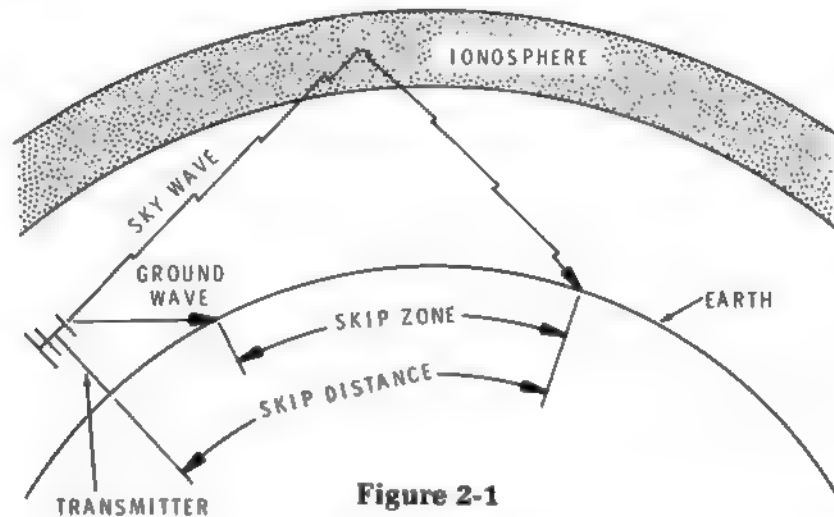


Figure 2-1

A radio wave that travels along the ground is called a "ground wave."

As shown, the distance a ground wave travels depends largely on the curvature of the earth's surface.

A radio wave that travels along the ground is called a \_\_\_\_\_.

ground wave

3. What is the region of ionized gases above the earth called?
- A. The troposphere.
  - B. The ionosphere.
  - C. The radio region.
  - D. The 50-mile high region.
  - E. None of the above.

B



4. As mentioned earlier, some radio waves travel upward toward the ionosphere. When these radio waves strike the ionosphere, the waves are refracted (bent) back toward the earth. Refer again to Figure 2-1.

**A radio wave that travels upward, is bent by the ionosphere, and returns to the earth is called a "sky wave."**

As you can see from the Figure, sky waves travel a farther distance than the ground wave. The distance depends on the height and condition of the ionosphere at a given time.

A radio wave that travels upward, is bent by the ionosphere, and returns to the earth is called a \_\_\_\_\_.

sky wave

5. What is a radio wave that travels along the ground called?

- A. A ground wave.
- B. A neutral wave.
- C. A sky wave.
- D. An earth wave.
- E. A surface wave.

A

6. What is the layer of ionized gases above the earth called?

- A. The 50-mile layer.
- B. The troposphere.
- C. The radio region.
- D. The ionosphere.
- E. The atmosphere.

D

7. Even though only one sky wave bounce is shown in the illustration, these waves can bounce several times between the earth and the ionosphere.

**The distance between the transmitter and the first bounce of the sky wave on the earth is called the skip distance.**

The distance between the transmitter and the first bounce of the sky wave on the earth is called the \_\_\_\_\_.

skip distance

8. What is a radio wave that travels upward, is bent by the ionosphere, and returns to the earth called.

- A. A sky wave.
- B. A ground wave.
- C. An atmospheric wave.
- D. A bouncing wave.
- E. A refracting wave.

A

9. What is the radio wave that travels along the ground called.

- A. A sky wave.
- B. An earth wave.
- C. A neutral wave.
- D. A surface wave.
- E. A ground wave.

E

10. In contrast to the skip distance (which was the distance between the transmitter and the first bounce of the sky wave), there is an area called the skip zone.

**The skip zone is the difference between the ground wave range and the point where the sky wave first strikes the earth.**

A receiver in the skip zone will most likely not receive the signal from the transmitter, since the ground wave signal has diminished to nothing and the sky wave bounces over the receiver.

The difference between the ground wave range and the point where the sky wave first strikes the earth is called the \_\_\_\_\_.

skip zone

11. What is the distance between the transmitter and the first bounce of the sky wave on the earth called?

- A. The skip zone.
- B. The ground wave distance.
- C. The skip distance.
- D. The bounce distance.
- E. The transmitter's maximum range.

C

12. What is a radio wave that travels upward, is bent by the ionosphere, and returns to the earth called?

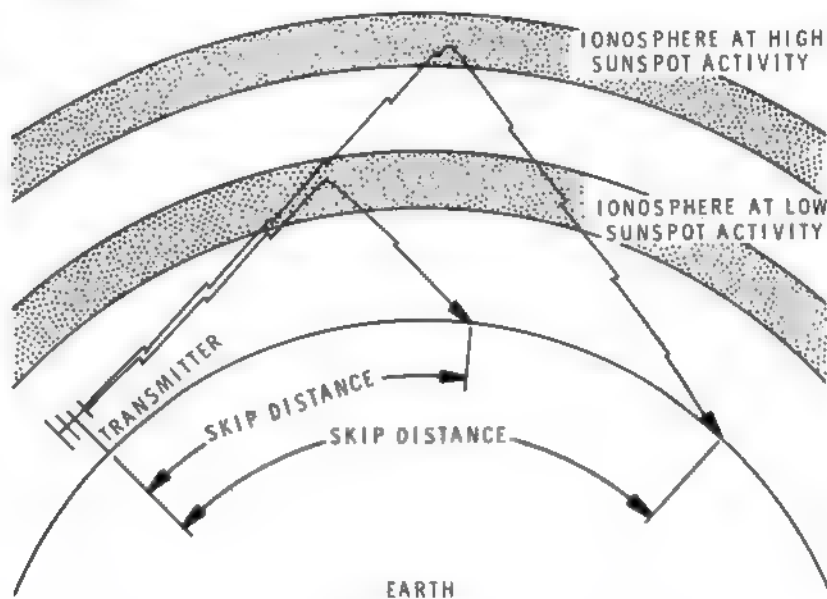
- A. A ground wave.
- B. A sky wave.
- C. A bounce wave.
- D. A refracting wave.
- E. An atmospheric wave.

B

13. The ionized layers in the ionosphere change in density and distance above the earth in 11-year cycles (approximate). The number of sunspots occurring on the sun cause these changes which proportionally affect radio waves.

**The 11-year cycle which causes changes in the layers of the ionosphere is called the "sunspot cycle."**

As shown in Figure 2-2, the more sunspots at a given time, the higher the ionized layers are above the earth. This, in turn, increases the skip distance which increases the transmitter's range.



**Figure 2-2**

The 11-year cycle which causes changes in the layers of the ionosphere is called the \_\_\_\_\_.

sunspot cycle

14. What is the difference between the ground wave range and the point where the sky wave first strikes the earth called?

- A. The bounce difference.
- B. The ground wave distance.
- C. The skip distance.
- D. The skip zone.
- E. The strike distance.

D

15. What is the distance between the transmitter and the first bounce of the sky wave called?

- A. The skip distance.
- B. The ground wave distance.
- C. The skip zone.
- D. The bounce distance.
- E. The transmittter's maximum range.

A

- 16.** Frequency is measured in hertz (Hz), kilohertz (kHz), or megahertz (MHz). There is a direct relationship between these three measurements just as there is between inches, feet, and yards.

$$1000 \text{ Hz} = \text{kHz}$$

$$1000 \text{ kHz} = 1 \text{ MHz (or } 1,000,000 \text{ Hz} = 1 \text{ MHz)}$$

To convert between Hz, kHz, and MHz, apply this information in the following examples.

**EXAMPLE 1:** What is the frequency 3700 kHz in MHz?

1000 kHz = 1 MHz, and 3700 kHz = 3.700 MHz.  
(normally the zeros are dropped, which leaves 3.7 MHz).

**EXAMPLE 2:** What is the frequency 7.150 MHz in kHz?

Since 1000 kHz = 1 MHz, then 7.150 MHz = 7150 kHz.

The frequency 21,150 kHz is the same as \_\_\_\_\_ MHz.

- 17.** What is the 11-year cycle which causes changes in the layers of the ionosphere called?

- A. The 11-year cycle.
- B. The ionospheric cycle.
- C. The sun cycle.
- D. The atmospheric cycle.
- E. The sunspot cycle.

18. What is the difference between the ground wave range and the point where the sky wave first strikes the earth called?

- A. The skip distance.
- B. The strike distance.
- C. The skip zone.
- D. The ground wave distance.
- E. The bounce difference.

C

19. In Module 1, frequency is measured in both kHz (or MHz) and meters.

The length in meters of one cycle of a radio wave is called "wavelength."

To convert the frequency in Hz to the wavelength in meters, divide 300,000,000 by the frequency.

The length in meters of one cycle of a radio wave is called \_\_\_\_\_.

wavelength

20. What is the frequency 3.75 MHz in kHz?

- A. 375 kHz.
- B. 37.5 kHz.
- C. 3750 kHz.
- D. .375 kHz.
- E. 80 kHz.

C

21. What is the 11-year cycle which causes changes in the layers of the ionosphere called?

- A. The atmospheric cycle.
- B. The sunspot cycle.
- C. The wavelength.
- D. The 11-year cycle.
- E. The ionospheric cycle.

B

22. The amateur bands (80, 40, 15, and 10 meters) do not give the same results at all hours of the day.

**During the daytime, the 15- and 10-meter bands usually give the best range.**

The usefulness of each band depends highly on the date, time of day, and sunspot activity.

During the daytime, the \_\_\_\_\_ - and \_\_\_\_\_ -meter bands usually give the best range.

15, 10

23. What is the length in meters of one cycle of a radio wave called?

- A. Kilohertz.
- B. Megahertz.
- C. Hertz.
- D. Wavelength.
- E. All of the above.

D



**24.** What is the frequency 7150 kHz in MHz?

- A. 7.15 MHz.
- B. 71.5 MHz.
- C. 715 MHz.
- D. 40 MHz.
- E. .715 MHz.

A

**25.** During the nighttime, the 80- and 40-meter bands are the most reliable.

Again, the usefulness of these bands is affected by the same factors as the daytime bands.

During the nighttime, the \_\_\_\_\_- and \_\_\_\_\_-meter bands are the most reliable.

80, 40

**26.** Which amateur bands give the best results during the daytime?

- A. The 80- and 40-meter bands.
- B. The 80- and 40-megahertz bands.
- B. The 15- and 10-kilohertz bands.
- D. The 15- and 10-megahertz bands.
- E. The 15- and 10-meter bands.

E

27. What unit is wavelength expressed in?

- A. Megahertz.
- B. Meters.
- C. Kilohertz.
- D. Hertz.
- E. None of the above.

B

28. As we previously mentioned, the amateur bands do not give the same results at all times of the day. Another condition that affects the amateur bands is the season.

**The 15- and 10-meter amateur bands give the best distance during the summer months.**

The \_\_\_\_\_- and \_\_\_\_\_-meter amateur bands give the best distance during the summer months.

15 10

29. Which amateur bands give the best results during the nighttime?

- A. The 15- and 10-meter bands.
- B. The 80- and 40-megahertz bands.
- C. The 80- and 40-meter bands.
- D. The 15- and 10-megahertz bands.
- E. The 80- and 40-kilohertz bands.

C

**30. Which amateur bands give the best results during the daytime?**

- A. The 15- and 10-meter bands.
- B. The 15- and 10-megahertz bands.
- C. The 80- and 40-meter bands.
- D. The 80- and 40-megahertz bands.
- E. The 80- and 40-kilohertz bands.

A

**31. The 80- and 40-meter amateur bands give the best distance during the winter months.**

The \_\_\_\_\_- and \_\_\_\_\_-meter amateur bands give the best distance during the winter months.

80 40

**32. Which amateur bands give the best distance during the summer months?**

- A. The 15- and 10-kilohertz bands.
- B. The 15- and 10-megahertz bands.
- C. The 80- and 40-meter bands.
- D. The 15- and 10-meter bands.
- E. The 80- and 40-megahertz bands.

D

**33. Which amateur bands give the best results during the nighttime?**

- A. The 15- and 10-meter bands.
- B. The 80- and 40-meter bands.
- C. The 80- and 40-megahertz bands.
- D. The 15- and 10-megahertz bands.
- E. The 80- and 40-kilohertz bands.

B

34. Earlier, you learned that the length in meters of one cycle of a radio wave is called wavelength.

The velocity (speed) of a radio wave in space is 300,000,000 meters per second.

The velocity of a radio wave in space is \_\_\_\_\_ meters per second.

300,000,000

35. Which amateur bands give the best distance during the winter months?

- A. The 15- and 10-meter bands.
- B. The 80- and 40-kilohertz bands.
- C. The 80- and 40-megahertz bands.
- D. The 15- and 10-megahertz bands.
- E. The 80- and 40-meter bands.

36. Which amateur bands give the best distance during the summer months?

- A. The 15- and 10-megahertz bands.
- B. The 80- and 40-meter bands.
- C. The 15- and 10-meter bands.
- D. The 80- and 40-megahertz bands.
- E. The 15- and 10-kilohertz bands.

37. As mentioned earlier, frequency can be expressed in terms of hertz (or kilohertz and megahertz) or wavelength in meters.

To find the wavelength in meters (when you are given the frequency in hertz), divide 300,000,000 by the frequency in hertz.

EXAMPLE: What is the wavelength of 7,100 kHz?

First, change kilohertz to hertz (7100 kHz = 7,100,000 Hz).

Now, divide 300,000,000 by 7,100,000 Hz.

$$\frac{300,000,000}{7,100,000} = 42.25 \text{ meters}$$

To find the wavelength in meters, divide \_\_\_\_\_ by the frequency in \_\_\_\_\_.

300,000,000      hertz

38. What is the velocity of a radio wave in space?

- A. 300,000,000 meters per second.
- B. 300,000,000 feet per second.
- C. 300,000 meters per second.
- D. 300 meters per second.
- E. 300,000 feet per second.

A

39. Which amateur bands give the best distance during the winter months?

- A. The 15- and 10-meter bands.
- B. The 80- and 40-kilohertz bands.
- C. The 80- and 40-megahertz bands.
- D. The 15- and 40-megahertz bands.
- E. The 80- and 40-meter bands.

E

40. To find the frequency of a wavelength, divide 300,000,000 by the wavelength.

EXAMPLE: What is the frequency of 80 meters?

$$300,000,000 \div 80 = 3,750,000 \text{ hertz.}$$

NOTE: 3,750,000 hertz is the same as 3,750 kilohertz or 3.75 megahertz.

To find the frequency of a wavelength, divide \_\_\_\_\_ by the \_\_\_\_\_.

300,000,000      wavelength

41. What is the wavelength of 21.2 megahertz?

- A. 1.415 meters.
- B. 14.15 meters.
- C. 141.5 meters.
- D. 1415 meters.
- E. .1415 meters.

B

42. What is the velocity of a radio wave in space?

- A. 300,000 meters per second.
- B. 300,000,000 feet per second.
- C. 300 meters per second.
- D. 300,000,000 meters per second.
- E. 300,000 feet per second.

D

43. Since frequencies above about 30 megahertz **pass through** the ionosphere, they are not good for long-range communications.

**Long-range communications by way of the ionosphere are generally limited to the HF (high frequency) spectrum.**

VHF (very high frequencies), UHF (ultra high frequencies), and microwaves are not good for long-range communications.

Long-range communications by way of the ionosphere are generally limited to the \_\_\_\_\_ spectrum.

high frequency (HF)

44. What is the frequency of 10 meters?

- A. 300 megahertz.
- B. 3 megahertz.
- C. 30 megahertz.
- D. 3000 megahertz.
- E. .3 megahertz.

C

45. What is the wavelength of 15,000 kHz?

- A. 20 meters.
- B. .2 meters.
- C. 2 meters.
- D. 200 meters.
- E. 2000 meters.

A

**46.** Long range communications by way of the ionosphere are generally limited to what part of the radio spectrum?

- A. The VHF portion.
- B. The HF portion.
- C. The UHF portion.
- D. The microwave portion.
- E. None of the above.

B

**47.** What is the frequency of 40 meters?

- A. .75 megahertz.
- B. 7500 megahertz.
- C. 750 megahertz.
- D. 7.5 megahertz.
- E. 75 megahertz.

D

**48.** Long range communications by way of the ionosphere are generally limited to which part of the radio spectrum?

- A. The HF portion.
- B. The UHF portion.
- C. The microwave portion.
- D. The VHF portion.
- E. None of the above.

A



## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than three questions, go back and re-read this whole module.
- If you have less than three incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parenthesis, following the correct answer, refers you to the proper frame). Then proceed to the next module.

1. What is the layer of ionized gases above the earth called?

- A. The 50-mile layer.
- B. The troposphere.
- C. The radio region.
- D. The ionosphere.
- E. The atmosphere.

2. What is the radio wave that travels along the ground called?

- A. A sky wave.
- B. An earth wave.
- C. A neutral wave.
- D. A surface wave.
- E. A ground wave.

3. What is a radio wave that travels upward, is bent by the ionosphere, and returns to the earth called?

- A. A ground wave.
- B. A sky wave.
- C. A bounce wave.
- D. A refracting wave.
- E. An atmospheric wave.

4. What is the distance between the transmitter and the first bounce of the sky wave called?
  - A. The skip distance.
  - B. The ground wave distance.
  - C. The skip zone.
  - D. The bounce distance.
  - E. The transmitter's maximum range.
5. What is the distance between the ground wave range and the point where the sky wave first strikes the earth called?
  - A. The skip distance.
  - B. The strike distance.
  - C. The skip zone.
  - D. The ground wave distance.
  - E. The bounce difference.
6. What is the 11-year cycle which causes changes in the layers of the ionosphere called?
  - A. The atmospheric cycle.
  - B. The sunspot cycle.
  - C. The wavelength.
  - D. The 11-year cycle.
  - E. The ionospheric cycle.
7. What is the frequency 7150 kHz in MHz?
  - A. 7.15 MHz.
  - B. 71.5 MHz.
  - C. 715 MHz.
  - D. 40 MHz
  - E. .715 MHz.
8. What is the length in meters of one cycle of a radio wave called?
  - A. Kilohertz.
  - B. Megahertz.
  - C. Hertz.
  - D. Wavelength.
  - E. All of the above.

9. Which amateur bands give the best results during the daytime?
- A. The 15- and 10-meter bands.
  - B. The 15- and 10-megahertz bands.
  - C. The 80- and 40-meter bands.
  - D. The 80- and 40-megahertz bands.
  - E. The 80- and 40-kilohertz bands.
10. Which amateur bands give the best results during the nighttime?
- A. The 15- and 10-meter bands.
  - B. The 80- and 40-meter bands.
  - C. The 80- and 40-megahertz bands.
  - D. The 15- and 10-megahertz bands.
  - E. The 80- and 40-kilohertz bands.
11. Which amateur bands give the best distance during the summer months?
- A. The 15- and 10-megahertz bands.
  - B. The 80- and 40-meter bands.
  - C. The 15- and 10-meter bands.
  - D. The 80- and 40-megahertz bands.
  - E. The 15- and 10-kilohertz bands.
12. Which amateur bands give the best distance during the winter months?
- A. The 15- and 10-meter bands.
  - B. The 80- and 40-kilohertz bands.
  - C. The 80- and 40-megahertz bands.
  - D. The 15- and 10-megahertz bands.
  - E. The 80- and 40-meter bands.
13. What is the velocity of a radio wave in space?
- A. 300,000,000 feet per second.
  - B. 300,000 meters per second.
  - C. 3,000 meters per second.
  - D. 300,000,000 meters per second.
  - E. 300 meters per second.

14. What is the wavelength of 15,000 kHz?
- A. 20 meters.
  - B. .2 meters.
  - C. 2 meters.
  - D. 200 meters.
  - E. 2000 meters.
15. What is the frequency of 40 meters?
- A. .75 megahertz.
  - B. 7500 megahertz.
  - C. 750 megahertz.
  - D. 7.5 megahertz.
  - E. 75 megahertz.
16. Long range communications by way of the ionosphere are generally limited to which part of the radio spectrum?
- A. The HF portion.
  - B. The UHF portion.
  - C. The microwave portion.
  - D. The VHF portion.
  - E. None of the above.



**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	A	(7)
5.	C	(10)
6.	B	(13)
7.	A	(16)
8.	D	(19)
9.	A	(22)
10.	B	(25)
11.	C	(28)
12.	E	(31)
13.	D	(34)
14.	A	(37)
15.	D	(40)
16.	A	(43)





# Individual Learning Program

In

## AMATEUR RADIO

(NOVICE LICENSE)

3

OPERATING  
PROCEDURES







# Individual Learning Program

## AMATEUR RADIO (NOVICE LICENSE)

### *Module 3* OPERATING PROCEDURES ER-3701

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BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When you complete this module, you will be able to select:

1. The three basic good operating habits.
2. The proper methods of picking a frequency.
3. The definition of "Q" signals.
4. The meaning of "QRM."
5. The meaning of "QRS."
6. The meaning of "QRU."
7. The meaning of "QRZ."
8. The meaning of "QSL."
9. The meaning of "QTH."
10. The meaning of "RST."
11. The correct code speed to use to answer another station.
12. The meaning of "CQ."
13. The meaning of "DE."
14. The meaning of "EST."
15. The meaning of "UTC."
16. The meaning of "CW."
17. The meaning of "AR."
18. The meaning of "SK."
19. The meaning of "K."
20. The meaning of "DX."
21. When operation is permitted on emergency frequencies.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than four questions, read this whole module.
  - If you have less than four incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or you can skip this module and proceed to the next module.
1. Which of the following is a good operating habit?
    - A. Listen on a frequency to see if it is in use before you transmit.
    - B. Use a dummy load when you tune up or adjust a transmitter.
    - C. Use the minimum power necessary to maintain communications.
    - D. Use courtesy.
    - E. All of the above.
  2. Which of the following should you do when you select an operating frequency?
    - A. Avoid interfering with existing communications.
    - B. Consider the bandwidth of the type of emission you are going to use.
    - C. Select a band that will give you the desired distance.
    - D. Listen for a clear frequency within the band.
    - E. All of the above.
  3. What is a Q signal?
    - A. A secret code.
    - B. A report of signal quality.
    - C. A call for any station to answer.
    - D. A type of abbreviation for common messages and questions.
    - E. A distress call.

4. What does QRM? mean?

- A. You are sending too fast.
- B. Am I being interfered with?
- C. Do you have a radio message for my station?
- D. You are being interfered with.
- E. Do you have anything for me?

5. What does QRS? mean?

- A. You are sending too fast.
- B. Who is calling me?
- C. Am I sending too fast?
- D. Do you have anything for me?
- E. Am I being interfered with?

6. What does QRU mean?

- A. I have nothing for you.
- B. You are being interfered with.
- C. You are being called by . . . . .
- D. You are sending too fast.
- E. Do you have anything for me?

7. What does QRZ mean?

- A. Who is calling me?
- B. You are sending too fast.
- C. I have nothing for you.
- D. You are being called by . . . . .
- E. None of the above.

8. What does QSL mean?

- A. I acknowledge receipt.
- B. I have nothing for you.
- C. You are being called by . . . . .
- D. Can you acknowledge receipt?
- E. You are sending too fast.

9. What does QTH? mean?
- A. My location is . . . . .
  - B. What is your location?
  - C. Who is calling me?
  - D. Am I sending too fast?
  - E. Do you have anything for me?
10. Which of the following is the best signal report?
- A. 599.
  - B. 579K.
  - C. 599X.
  - D. 599C.
  - E. 111.
11. What code speed should you use when you are communicating with another station?
- A. 13 words per minute.
  - B. 5 words per minute.
  - C. As fast as you can send it.
  - D. As fast as you can copy it.
  - E. Same speed as the other station.
12. Which of the following is a general call for any station?
- A. A question mark.
  - B. CQ.
  - C. QC.
  - D. QRZ?
  - E. DE.
13. Which of the following should you use in place of "this is" in code?
- A. CQ.
  - B. QSL.
  - C. DE.
  - D. "From."
  - E. =.

14. Which of the following is the abbreviation for Eastern Standard Time?
- A. ETS.
  - B. UTC.
  - C. EST.
  - D. UCT.
  - E. GMT.
15. Which of the following is the abbreviation for Universal Coordinated Time?
- A. EST.
  - B. UTC.
  - C. GMT.
  - D. UCT.
  - E. Zulu.
16. Which of the following is the **abbreviation** for continuous waves.
- A.  $\overline{\text{CW}}$ .
  - B. A1.
  - C. QCW.
  - D. Code.
  - E. CW.
17. Which of the following letter groups means "end of message?"
- A.  $\overline{\text{EM}}$ .
  - B.  $\overline{\text{SK}}$ .
  - C.  $\overline{\text{AR}}$ .
  - D. AR.
  - E. K.
18. Which of the following means "end of communication, no reply is expected?"
- A. SK.
  - B.  $\overline{\text{AR}}$ .
  - C. AR.
  - D.  $\overline{\text{SK}}$ .
  - E. K.

19. Which of the following means “go ahead” or “over?”

- A. K.
- B. CW.
- C. SK.
- D. AR.
- E. DE.

20. Which of the following means distant?

- A. DE.
- B. DX.
- C. DX.
- D. DT.
- E. QTH.

21. Which must you do on an emergency frequency?

- A. Operate as usual if you were already using the frequency.
- B. Cease all operation on all frequencies.
- C. Cease operation on the emergency frequency unless you are legitimately participating in the emergency.
- D. Listen only.
- E. None of the above.



**PRETEST ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	E.	(1)
2.	E	(2)
3.	D	(4)
4.	B	(7)
5.	C	(10)
6.	A	(13)
7.	D	(16)
8.	A	(19)
9.	B	(22)
10.	C	(25)
11.	E	(28)
12.	B	(32)
13.	C	(35)
14.	C	(38)
15.	B	(41)
16.	E	(44)
17.	C	(47)
18.	D	(50)
19.	A	(53)
20.	B	(56)
21.	C	(59)

## INTRODUCTION

Amateur radio operators often use abbreviations to reduce the length of radio messages. Abbreviations are used occasionally in voice communications but are used to a much greater extent in code (CW) operation. You will probably learn many abbreviations during your first few contacts on the air. This module, therefore, will only cover the most common ones. This module will also teach you some proper operating techniques.

## PROGRAMMED INSTRUCTION

1. Since there are more than 500,000 amateur radio operators in the world, some method must be used to minimize interference between stations and congestion within the amateur bands.

**The three basic good operating habits that each amateur should abide by are:**

1. **Use the minimum power necessary to maintain communications.**
2. **Listen on a frequency to see if it is in use before you transmit.**
3. **Use a dummy load when you tune up or adjust your transmitter.**

**The three basic good operating habits that each amateur should abide by are:**

1. Use the \_\_\_\_\_ power necessary to maintain communications.
2. \_\_\_\_\_ on a frequency to see if it is in use before you transmit.
3. Use a \_\_\_\_\_ load when you tune up or adjust your transmitter.

minimum, listen, dummy

2. Although there are many frequencies where amateurs may operate, there are three things you should do before you select an operating frequency.

The three things you should do when you select an operating frequency are:

1. Select the band that will give the distance you desire.
2. Listen for a clear frequency within the band.
3. Consider the bandwidth of the type of emission you are going to use when you are operating near a band edge.

The bandwidth of an A1 signal (authorized for novices) in hertz is approximately equal to four times the code speed in words per minute.

The three things you should do when you select an operating frequency are:

1. \_\_\_\_\_ the band that will give the \_\_\_\_\_ you desire.
2. \_\_\_\_\_ for a clear frequency within the band.
3. Consider the \_\_\_\_\_ of the type of emission you are going to use when you operate near a band edge.

Select, distance, Listen, bandwidth

3. Which of the following is **not** a good operating habit?

- A. Use the maximum power you are authorized.
- B. Use the minimum power necessary to maintain communications.
- C. Listen on a frequency to see if it is in use before you transmit.
- D. Use a dummy load when you tune up or adjust your transmitter.
- E. All of the above.

1

4. Amateur radio operators (as well as some other services) use a type of abbreviation called "Q signals."

The purpose of Q signals is to shorten commonly used radio messages and questions.

Each Q signal can be changed to a question by simply adding a question mark after it.

Amateur radio operators use a type of abbreviation called "\_\_\_\_\_."

Q signals

5. Which of the following should **not** be done when you are selecting an operating frequency?

- A. Select a band that will give you the desired distance.
- B. Consider the bandwidth of the type of emission you are going to use.
- C. Listen for a clear frequency within the band.
- D. Avoid interference to existing communications.
- E. None of the above.

1

6. Which of the following is a good operating habit?

- A. Listen on a frequency to see if it is in use before you transmit.
- B. Use a dummy load when you tune up or adjust a transmitter.
- C. Use the minimum power necessary to maintain communications.
- D. Use courtesy.
- E. All of the above.

F

7. QRM means "you are being interfered with."

Likewise, QRM? means "Am I being interfered with?"

The Q signal for "You are being interfered with" is

\_\_\_\_\_.

QRM

8. A Q signal is . . . . .

- A. A report of signal quality.
- B. A secret code.
- C. A type of abbreviation for common messages and questions.
- D. A call for any station to answer.
- E. A distress call.

(

9. Which of the following should be done when you select an operating frequency?

- A. Avoid interference to existing communications.
- B. Consider the bandwidth of the type of emission you are going to use.
- C. Select a band that will give you the desired distance.
- D. Listen for a clear frequency within the band.
- E. All of the above.

E

10. QRS means "You are sending too fast for me."

Similarly, QRS? means "Am I sending too fast for you?"

The Q signal for "You are sending too fast" is \_\_\_\_\_.

QRS

11. What does QRM mean?

- A. You are sending too fast.
- B. You are being interfered with.
- C. I have a radio message for your station.
- D. I am a message route manager.
- E. Am I being interfered with?

B

12. A Q signal is . . . . .

- A. A secret code.
- B. A report of signal quality.
- C. A call for any station to answer.
- D. A type of abbreviation for common messages and questions.
- E. A distress call.

D

13. QRU means "I have nothing for you."

QRU? means "Do you have anything for me?"

The Q signal for "I have nothing for you" is \_\_\_\_\_.

QRI

14. What does QRS mean?

- A. You are sending too fast.
- B. You are being interfered with.
- C. You are sending too slow.
- D. I have nothing for you.
- E. Am I sending too fast?

A

15. What does QRM? mean?

- A. You are sending too fast.
- B. Am I being interfered with?
- C. Do you have a radio message for my station?
- D. You are being interfered with.
- E. Do you have anything for me?

B

16. QRZ means "You are being called by . . . . ."

QRZ? means "Who is calling me?" (This does **not** mean the same thing as "CQ," which you will learn later.)

The Q signal for "You are being called by . . . . . " is \_\_\_\_\_.

QRZ

17. What does QRU mean?

- A. You are being interfered with.
- B. Do you have anything for me?
- C. I have nothing for you.
- D. You are being called by . . . . .
- E. You are sending too fast.

C



18. What does QRS? mean?

- A. You are sending too fast.
- B. Who is calling me?
- C. Am I being interfered with?
- D. Do you have anything for me?
- E. Am I sending too fast?

E

19. QSL means "I acknowledge receipt." (In other words, "I received the message okay.")

QSL? means "Can you acknowledge receipt?"

The Q signal for "I acknowledge receipt" is \_\_\_\_\_.

QSL

20. What does QRZ mean?

- A. Who is calling me?
- B. You are sending too fast.
- C. I have nothing for you.
- D. You are being called by . . . . .
- E. None of the above.

D

21. What does QRU? mean?

- A. Do you have anything for me?
- B. I have nothing for you.
- C. Am I sending too fast?
- D. Am I being interfered with?
- E. Can you acknowledge receipt?

A

22. QTH means "My location is . . . . ."

QTH? means "What is your location?"

The Q signal for "My location is . . . . ." is \_\_\_\_\_.

QTH

23. What does QSL mean?

- A. I acknowledge receipt.
- B. I have nothing for you.
- C. You are being called by . . . . .
- D. Can you acknowledge receipt?
- E. You are sending too fast.

A

24. What does QRZ? mean?

- A. Am I sending too fast?
- B. Who is calling me?
- C. Can you acknowledge receipt?
- D. Am I being interfered with?
- E. You are being called by . . . . .

B

25. Amateur radio operators use a signal reporting system called the "RST system." The letters R, S, and T stand for Readability, Strength, and Tone as shown below.

#### THE R-S-T SYSTEM

##### READABILITY

- 1 — Unreadable.
- 2 — Barely readable, occasional words distinguishable.
- 3 — Readable with considerable difficulty.
- 4 — Readable with practically no difficulty.
- 5 — Perfectly readable.

##### SIGNAL STRENGTH

- 1 — Faint signals barely perceptible.
- 2 — Very weak signals.
- 3 — Weak signals.
- 4 — Fair signals.
- 5 — Fairly good signals.
- 6 — Good signals.
- 7 — Moderately strong signals.
- 8 — Strong signals.
- 9 — Extremely strong signals.

##### tone

- 1 — Sixty hertz AC or less, very rough and broad.
- 2 — Very rough AC, very harsh sound.
- 3 — Rough AC tone, rectified but not filtered.
- 4 — Rough tone, some trace of filtering.
- 5 — Filtered rectified AC but strongly ripple-modulated.
- 6 — Filtered tone, definite trace of ripple modulation.
- 7 — Near pure tone, trace of ripple modulation.
- 8 — Near perfect tone, slight trace of modulation.
- 9 — Perfect tone, no trace of ripple or modulation of any kind.

After the tone, the letter X can be added to signify that the signal is crystal steady. The letters C for chirp, K for clicks, or a combination of both can also be added.

**EXAMPLE:** A report of 589X means that your signal is perfectly readable, strong, and has a perfect tone quality that is very steady.

**NOTE:** The tone designation is not used in voice communications.

What does a report of 379C mean?

---



---

The signal is readable with considerable difficulty, moderately strong, is a perfect tone with chirp.

**26.** What does QTH mean?

- A. I acknowledge receipt.
- B. I have something for you.
- C. My location is . . . . .
- D. What is your location?
- E. You are sending too fast.

C.

**27.** What does QSL? mean?

- A. I acknowledge receipt.
- B. Who is calling me?
- C. Am I being interfered with?
- D. Am I sending too fast?
- E. Can you acknowledge receipt?

E.

28. As you tune across the amateur bands, you will notice that all amateurs send the code at different speeds.

**Always call or answer another amateur at his speed.**

This will reasonably ensure you that you are sending at a speed that is comfortable to him.

Always call or answer another amateur at \_\_\_\_\_ speed.

his

29. Which of the following is an excellent signal report?

- A. 111.
- B. 378.
- C. 479.
- D. 599.
- E. 555.

11

30. What does QTH? mean?

- A. My location is . . . . .
- B. What is your location?
- C. Who is calling me?
- D. Am I sending too fast?
- E. Do you have anything for me?

B

31. Write the number beside each of the following Q signals in the proper blanks at the right.

1. QTH.     \_\_\_\_\_ You are being called by . . . . .
2. QSL.     \_\_\_\_\_ I have nothing for you.
3. QRZ.     \_\_\_\_\_ I acknowledge receipt.
4. QRU.     \_\_\_\_\_ You are sending too fast.
5. QRS.     \_\_\_\_\_ You are being interfered with.
6. QRM.     \_\_\_\_\_ My location is . . . . .

3  
4  
2  
5  
6  
1

32. "CQ" is a general call for any station.

Amateurs call CQ when they wish to talk to any station.

The general call for any station is \_\_\_\_\_.

CQ

33. What code speed should you use when you are communicating with another station?

- A. Same speed as the other station.
- B. As fast as you can send it.
- C. 5 words per minute.
- D. 13 words per minute.
- E. 10 words per minute.

A

**34.** Which of the following is the best signal report?

- A. 599.
- B. 579K.
- C. 599X.
- D. 599C.
- E. 111.

C

**35.** "DE" is used in place of "this is" when you use code.

As an example, assume that W3XYZ is calling W8XYZ. In voice, you would say "W8XYZ this is W3XYZ." In code, you would send "W8XYZ DE W3XYZ."

The abbreviation for "this is" is \_\_\_\_\_.

D

**36.** Which of the following is a general call for any station?

- A. DE.
- B. QRZ?
- C. QC.
- D. A question mark.
- E. CQ.

E

**37.** What code speed should you use when you are communicating with another station?

- A. 13 words per minute.
- B. 5 words per minute.
- C. As fast as you can send it.
- D. As fast as you can copy it.
- E. Same speed as the other station.

E

**38.** EST is the common abbreviation for Eastern Standard Time.

The abbreviation for Eastern Standard Time is \_\_\_\_\_.

EST

**39.** Which of the following should you use in place of "this is" in code?

- A. CQ.
- B. QSL.
- C. "From."
- D. DE.
- E. None of the above.

D



40. Which of the following is a general call for any station?

- A. A question mark.
- B. CQ.
- C. QC.
- D. QRZ?
- E. DE.

B

41. Most amateurs refer to a universal time called Universal Coordinated Time. This helps amateurs all over the world convert the time into their own local time. It is much easier to remember the difference between Universal Coordinated Time and the local time than it is to remember what time the rest of the world is on.

**The abbreviation for Universal Coordinated Time is UTC. (Note that the last two letters are interchanged from what you might expect them to be.)**

Universal Coordinated Time was previously called Greenwich Mean Time (GMT). A conversion table is printed in the last Module of this course so you can convert your own local time to UTC. Usually, the word "zulu" or the letter "Z" is put behind the UTC time designation.

The abbreviation for Universal Coordinated Time is \_\_\_\_\_.

UTC.

42. Which of the following is the abbreviation for Eastern Standard Time?

- A. EST.
- B. ETS.
- C. UTC.
- D. GMT.
- E. UCT.

A

43. Which of the following should you use in place of "this is" in code?

- A. CQ.
- B. QSL.
- C. DE.
- D. "From."
- E. =

C

44. CW is the abbreviation for continuous waves (or code).

The abbreviation for continuous waves is \_\_\_\_\_.

CW

45. Which of the following is the abbreviation for Universal Coordinated Time?

- A. GMT.
- B. UCT.
- C. EST.
- D. UTC.
- E. Z.

D

46. Which of the following is the abbreviation for Eastern Standard Time?

- A. ETS.
- B. UTC.
- C. EST.
- D. UCT.
- E. GMT.

C

47. When you use CW, there are a few letter groups which are actually abbreviations. One of these two-letter groups is  $\overline{\text{AR}}$ .

**The letter group  $\overline{\text{AR}}$  means "end of message."**

The bar above the two letters indicate that these letters are run together on CW. In other words, there is no space between the letters (•—•—•).

The abbreviation for "end of message" is \_\_\_\_\_.

$\overline{\text{AR}}$

48. Which of the following is the **abbreviation** for continuous waves?

- A. Code.
- B. CW.
- C. A1.
- D. QRM.
- E. QCW.

B

49. Which of the following is the abbreviation for Universal Coordinated Time?

- A. EST.
- B. UTC.
- C. GMT.
- D. UCT.
- E. Zulu.

B

50. The letter group **SK** means "end of communication, no reply is expected."

The letter group meaning "end of communication, no reply is expected" is \_\_\_\_\_.

SK

51. Which of the following letter groups means "end of message?"

- A. AR.
- B. SK
- C. RA.
- D. EM.
- E. AR.

.A

52. Which of the following is the **abbreviation** for continuous waves?

- A. CW.
- B. A1.
- C. QCW.
- D. Code.
- E. CW.

E

53. The letter K sent by itself at the end of a transmission means "go ahead" or "over."

Usually this letter K is sent with slightly longer dashes than the regular K.

The letter meaning "go ahead" or "over" is \_\_\_\_\_.

K

54. Which of the following means "end of communication, no reply is expected?"

- A. SK.
- B. AR.
- C. SK.
- D. AR.
- E. EC.

C

55. Which of the following letter groups means "end of message?"

- A. EM.
- B. SK.
- C. AR.
- D. AR.
- E. K.

C

56. DX means distant.

Usually DX refers to stations in foreign countries.

A distant station is called \_\_\_\_\_.

DX

57. Which of the following means "go ahead" or "over?"

- A. CW.
- B. SK.
- C. AR.
- D. K.
- E. DE.

D

58. Which of the following means "end of communication, no reply is expected?"

- A. SK.
- B. AR.
- C. AR.
- D. SK.
- E. K.

D

59. In an emergency, the FCC may declare certain frequencies as emergency frequencies.

**You must not operate on an emergency channel unless you are legitimately participating in the emergency.**

You must not operate on an emergency channel unless you are \_\_\_\_\_ in the emergency.

legitimately participating

60. Which of the following means distant?

- A. DT.
- B. DX.
- C. DX.
- D. DE.
- E. QTH.

B

61. Which of the following means "go ahead" or "over?"

- A. K.
- B. CW.
- C. SK.
- D. AR.
- E. DE.

A

62. What should you do on an emergency frequency?

- A. Cease operation on all frequencies.
- B. Operate as usual if you were already using the frequency.
- C. Operate as usual but clear off the frequency as soon as convenient.
- D. Listen only.
- E. Cease operation on the emergency frequency unless you are legitimately participating in the emergency.

E



63. Which of the following means distant?

- A. DE.
- B. DX.
- C. ~~DX~~.
- D. DT.
- E. QTH.

B

64. Write the number beside each of the following abbreviations in the proper blanks at the right.

- |              |   |
|--------------|---|
| 1. CQ        | _____ Eastern Standard Time.                        |
| 2. DE        | _____ Continuous Waves.                             |
| 3. EST       | _____ "This is."                                    |
| 4. UTC       | _____ "End of message."                             |
| 5. CW        | _____ A general call for any station.               |
| 6. <u>AR</u> | _____ "Go ahead" or "over."                         |
| 7. <u>SK</u> | _____ Distant.                                      |
| 8. K         | _____ Universal Coordinated Time.                   |
| 9. DX        | _____ "End of communication, no reply is expected." |

3  
5  
2  
6  
1  
8  
9  
4  
7

65. What must you do on an emergency frequency?

- A. Operate as usual if you were already using the frequency.
- B. Cease operation on all frequencies.
- C. Cease operation on the emergency frequency unless you are legitimately participating in the emergency.
- D. Listen only.
- E. None of the above.

C

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than four questions, go back and re-read this whole module.
- If you have less than four incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parenthesis, following the correct answer, refers you to the proper frame). Then proceed to the next module.

1. Which of the following is a good operating habit?

- A. Listen on a frequency to see if it is in use before you transmit.
- B. Use a dummy load when you tune up or adjust a transmitter.
- C. Use the minimum power necessary to maintain communications.
- D. Use courtesy.
- E. All of the above.

2. Which of the following should you do when you select an operating frequency?

- A. Avoid interfering with existing communications.
- B. Consider the bandwidth of the type of emission you are going to use.
- C. Select a band that will give you the desired distance.
- D. Listen for a clear frequency within the band.
- E. All of the above.

3. What is a Q signal?

- A. A secret code.
- B. A report of signal quality.
- C. A call for any station to answer.
- D. A type of abbreviation for common messages and questions.
- E. A distress call.

4. What does QRM? mean?

- A. You are sending too fast.
- B. Am I being interfered with?
- C. Do you have a radio message for my station?
- D. You are being interfered with.
- E. Do you have anything for me?

5. What does QRS? mean?

- A. You are sending too fast.
- B. Who is calling me?
- C. Am I sending too fast?
- D. Do you have anything for me?
- E. Am I being interfered with?

6. What does QRU mean?

- A. I have nothing for you.
- B. You are being interfered with.
- C. You are being called by . . . . .
- D. You are sending too fast.
- E. Do you have anything for me?

7. What does QRZ mean?

- A. Who is calling me?
- B. You are sending too fast.
- C. I have nothing for you.
- D. You are being called by . . . . .
- E. None of the above.

8. What does QSL mean?
- A. I acknowledge receipt.
  - B. I have nothing for you.
  - C. You are being called by . . . . .
  - D. Can you acknowledge receipt?
  - E. You are sending too fast.
9. What does QTH? mean?
- A. My location is . . . . .
  - B. What is your location?
  - C. Who is calling me?
  - D. Am I sending too fast?
  - E. Do you have anything for me?
10. Which of the following is the best signal report?
- A. 599.
  - B. 579K.
  - C. 599X.
  - D. 599C.
  - E. 111.
11. What code speed should you use when you are communicating with another station?
- A. 13 words per minute.
  - B. 5 words per minute.
  - C. As fast as you can send it.
  - D. As fast as you can copy it.
  - E. Same speed as the other station.
12. Which of the following is a general call for any station?
- A. A question mark.
  - B. CQ.
  - C. QC.
  - D. QRZ?
  - E. DE.

13. Which of the following should you use in place of "this is" in code?

- A. CQ.
- B. QSL.
- C. DE.
- D. "From."
- E. =.

14. Which of the following is the abbreviation for Eastern Standard Time?

- A. ETS.
- B. UTC.
- C. EST.
- D. UCT.
- E. GMT.

15. Which of the following is the abbreviation for Universal Coordinated Time?

- A. EST.
- B. UTC.
- C. GMT.
- D. UCT.
- E. Zulu.

16. Which of the following is the **abbreviation** for continuous waves.

- A. CW.
- B. A1.
- C. QCW.
- D. Code.
- E. CW.

17. Which of the following letter groups means "end of message?"

- A. EM.
- B. SK.
- C. AR.
- D. AR.
- E. K.

18. Which of the following means “end of communication, no reply is expected?”

- A. SK.
- B. AR.
- C. AR.
- D. SK.
- E. K.

19. Which of the following means “go ahead” or “over?”

- A. K.
- B. CW.
- C. SK.
- D. AR.
- E. DE.

20. Which of the following means distant?

- A. DE.
- B. DX.
- C. DX.
- D. DT.
- E. QTH.

21. Which must you do on an emergency frequency?

- A. Operate as usual if you were already using the frequency.
- B. Cease all operation on all frequencies.
- C. Cease operation on the emergency frequency unless you are legitimately participating in the emergency.
- D. Listen only.
- E. None of the above.





**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	E.	(1)
2.	E	(2)
3.	D	(4)
4.	B	(7)
5.	C	(10)
6.	A	(13)
7.	D	(16)
8.	A	(19)
9.	B	(22)
10.	C	(25)
11.	E	(28)
12.	B	(32)
13.	C	(35)
14.	C	(38)
15.	B	(41)
16.	E	(44)
17.	C	(47)
18.	D	(50)
19.	A	(53)
20.	B	(56)
21.	C	(59)



# Individual Learning Program

In

## AMATEUR RADIO

(NOVICE LICENSE)

EMISSION  
CHARACTERISTICS





# **Individual Learning Program**

## **AMATEUR RADIO** (NOVICE LICENSE)

### *Module 4* **EMISSION CHARACTERISTICS** ER-3701

**HEATH COMPANY**  
BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When have complete this module, you will be able to select:

1. The definition of a "spurious emission."
2. The definition of a "key click."
3. The definition of a "chirp."
4. The definition of "carrier frequency."
5. The definition of "frequency drift."
6. The definition of "continuous waves."
7. The definition of a "type A $\phi$  emission."
8. The definition of a "type A1 emission."
9. The characteristics of a good quality A1 emission.
10. A good method of keying a transmitter.
11. Methods of monitoring your transmitted signal.
12. A true statement concerning purity and stability of emissions.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare the answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than two questions, read this whole module.
- If you have less than two incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or you can skip this module and proceed to the next module.

**1. Select the best definition of a spurious emission.**

- A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
- B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
- C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- E. None of the above.

**2. Select the best definition of a key click.**

- A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
- B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
- C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
- D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
- E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

**3. Select the best definition of chirp.**

- A. Chirp is the name given a CW signal which changes slowly in frequency.
- B. Chirp is the name given a CW signal which changes quickly in frequency.
- C. Chirp is the name given an audio signal which changes slowly in frequency.
- D. Chirp is the name given an audio signal which changes quickly in frequency.
- E. All of the above.

**4. Select the best definition of carrier frequency.**

- A. Carrier frequency is always the frequency of the oscillator.
- B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
- C. Carrier frequency is always the frequency of the first multiplier stage.
- D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
- E. Carrier frequency is a spurious emission.

**5. Select the best definition of frequency drift.**

- A. Frequency drift is a fast change in the frequency of a signal.
- B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
- C. Frequency drift is the same thing as chirp.
- D. Frequency drift is a slow change in the frequency of a signal.
- E. None of the above.

**6. Select the best definition of continuous waves.**

- A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
- B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.

- C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
- D. Continuous waves are interrupted radio waves that are not modulated.
- E. Continuous waves are radio waves that have a constant amplitude and are not modulated.

7. What type of emission is a steady, unmodulated carrier wave?

- A. A2.
- B. A~~3~~.
- C. A1.
- D. F1.
- E. F~~3~~.

8. What type of emission is an interrupted, unmodulated carrier wave?

- A. A~~3~~.
- B. A2.
- C. A1.
- D. F1.
- E. F2.

9. Which of the following is characteristic of a good quality A1 emission?

- A. The emission should have many spurious emissions and a pure note.
- B. The emission should be free of spurious emissions and have a pure note.
- C. The emission should have many clicks and a pure note.
- D. The emission should have much chirp and a pure note.
- E. None of the above.

10. Which of the following is the best place to key a transmitter?

- A. A stage after the oscillator circuit.
- B. The oscillator circuit.
- C. A stage in front of the oscillator circuit.
- D. The antenna.
- E. The main power supply.



11. Which of the following is the best method of checking your transmitted signal?
- A. Use an amateur band receiver.
  - B. Use a communications type receiver.
  - C. Use an oscilloscope.
  - D. Use reception reports from other stations.
  - E. None of the above.
12. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?
- A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
  - B. The carrier wave must be as constant as the state of the art permits.
  - C. The carrier wave may vary in frequency as long as it starts within an amateur band.
  - D. The carrier wave may vary in frequency as long as it stays within an amateur band.
  - E. None of the above.

## PRETEST ANSWERS

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	B	(7)
5.	D	(10)
6.	E	(13)
7.	B	(16)
8.	C	(19)
9.	B	(22)
10.	A	(25)
11.	C	(28)
12.	B	(31)

## INTRODUCTION

All amateurs wish to transmit the best possible signal. This Module will teach you the terms associated with a transmitted signal and how to recognize some common problems. You will also learn how to check your signal for quality.

## PROGRAMMED INSTRUCTION

1. Occasionally, you may hear another amateur mention "spurious emissions" (also called "spurious signals").

**A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.**

Spurious emissions are in violation of the Rules and Regulations because they can interfere with other stations.

A spurious emission is any radiation from a transmitter which causes unwanted \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_ on either side of the operating frequency.

harmonics, clicks, oscillations

2. When you suddenly close or open a telegraph key, a current surge or "spike" occurs. This spike can cause unwanted clicks on frequencies surrounding the operating frequency and could interfere with other communications.

**A click on a nearby frequency that is caused when you close or open a telegraph key is called a key click.**

A click on a nearby frequency that is caused when you close or open a telegraph key is called a \_\_\_\_\_.

key click

**3. Which of the following is the correct definition of a spurious emission?**

- A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
- B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
- E. None of the above.

B

**4. The name given a CW signal which changes quickly in frequency (noticeable as a change in pitch) is called "chirp."**

Chirp is usually caused by an insufficient or poorly regulated power supply in the transmitter. A sudden load on the power supply, caused when you key the transmitter, causes the supply voltage to drop. This voltage drop, in turn, causes the transmitter frequency to change and causes a chirping sound.

The name given a CW signal which changes in frequency (noticeable as a change in pitch) is called \_\_\_\_\_.

chirp

5. Which of the following is the correct definition of a key click?

- A. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.
- B. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
- C. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
- D. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
- E. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.

A

6. Select the best definition of a spurious emission.

- A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
- B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
- C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- E. None of the above.

D

7. A transmitter operates on a specific frequency which is determined by the oscillator circuit and any multiplier stages that follow it.

**The frequency of the signal that actually leaves the transmitting antenna is called the carrier frequency.**

The frequency of the signal that actually leaves the transmitting antenna is called the \_\_\_\_\_.

carrier frequency

8. Which of the following is the best definition of chirp?

- A. Chirp is the name given a CW signal which changes slowly in frequency.
- B. Chirp is the name given a CW signal which changes quickly in frequency.
- C. Chirp is the name given an audio signal which changes quickly in frequency.
- D. Chirp is the name given an audio signal which changes slowly in frequency.
- E. All of the above.

B

9. Select the best definition of a key click.

- A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
- B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
- C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
- D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
- E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

E

10. Some signals may change frequency slowly. This is usually caused by heat affecting the oscillator and could happen in a receiver as well as a transmitter.

**A slow change in the frequency of a signal is called a frequency drift.**

A slow change in the frequency of a signal is called a \_\_\_\_\_.

frequency drift

11. Which of the following is the best definition of carrier frequency?

- A. Carrier frequency is always the frequency of the oscillator.
- B. Carrier frequency is always the frequency of the first multiplier stage.
- C. Carrier frequency is the frequency of the signal that actually leaves the antenna.
- D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
- E. Carrier frequency is an unwanted signal.

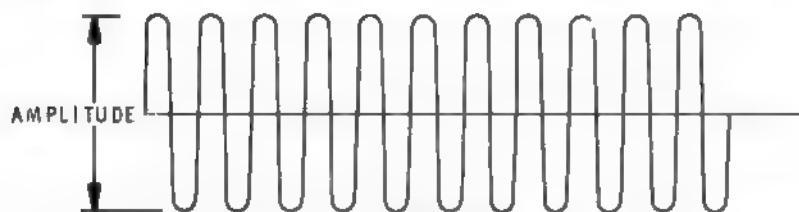
C

12. Select the best definition of chirp.

- A. Chirp is the name given a CW signal which changes slowly in frequency.
- B. Chirp is the name given a CW signal which changes quickly in frequency.
- C. Chirp is the name given an audio signal which changes slowly in frequency.
- D. Chirp is the name given an audio signal which changes quickly in frequency.
- E. All of the above.

B

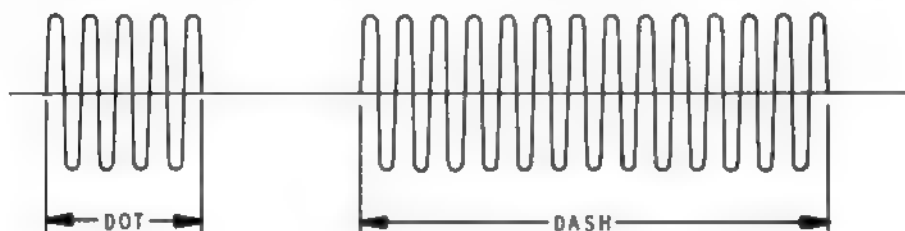
13. Radio waves that have a constant amplitude (size) and are not modulated are called continuous waves (see Figure 4-1).



A CONTINUOUS WAVE

Figure 4-1

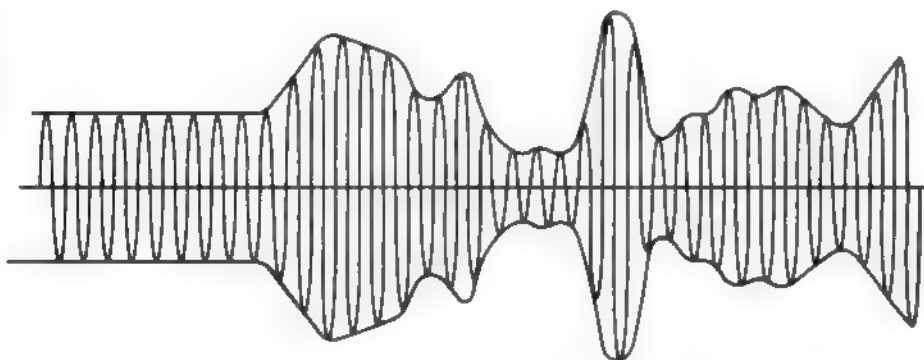
To send code, we simply turn a continuous wave on and off for different lengths of time as shown in Figure 4-2.



THE MORSE LETTER A

Figure 4-2

If we put speech on the continuous wave, it would look something like the wave shown in Figure 4-3.



CONTINUOUS WAVE WITH SPEECH ADDED

Figure 4-3

Radio waves that have a constant amplitude and are not modulated are called \_\_\_\_\_.

continuous waves



14. Which of the following is the best definition of frequency drift?
- A. Frequency drift is a slow change in the frequency of a signal.
  - B. Frequency drift is a fast change in the frequency of a signal.
  - C. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiple stage.
  - D. Frequency drift is the same thing as chirp.
  - E. None of the above.

A

15. Select the best definition of carrier frequency.
- A. Carrier frequency is always the frequency of the oscillator.
  - B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
  - C. Carrier frequency is always the frequency of the first multiplier stage.
  - D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
  - E. Carrier frequency is a spurious emission.

B

16. A steady, unmodulated carrier wave is called type ~~A~~ emission.
- A steady, unmodulated carrier wave is called type \_\_\_\_\_ emission.

~~A~~

**17. Which of the following is the best definition of continuous waves?**

- A. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
- B. Continuous waves are radio waves that have a changing amplitude and are not modulated.
- C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
- D. Continuous waves are radio waves that have a constant amplitude and are not modulated.
- E. Continuous waves are interrupted radio waves that are not modulated.

D

**18. Select the best definition of frequency drift.**

- A. Frequency drift is a fast change in the frequency of a signal.
- B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
- C. Frequency drift is the same thing as chirp.
- D. Frequency drift is a slow change in the frequency of a signal.
- E. None of the above.

D

**19. An interrupted, unmodulated carrier wave is called type A1 emission.**

As described in Module 1, type A1 emission is telegraphy (code) and is the only type of emission a novice may use.

An interrupted, unmodulated carrier wave is called type \_\_\_\_\_ emission.

A1

20. Which of the following is the best definition of type A<sub>1</sub> emission?

- A. Type A<sub>1</sub> emission is a steady, tone-modulated carrier wave.
- B. Type A<sub>1</sub> emission is an interrupted, unmodulated carrier wave.
- C. Type A<sub>1</sub> emission is a steady, unmodulated carrier wave.
- D. Type A<sub>1</sub> emission is a steady, voice-modulated carrier wave.
- E. Type A<sub>1</sub> emission is a telegraph transmission.

C.

21. Select the best definition of continuous waves.

- A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
- B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
- C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
- D. Continuous waves are interrupted radio waves that are not modulated.
- E. Continuous waves are radio waves that have a constant amplitude and are not modulated.

E.

22. All amateurs strive to transmit the best possible signals. This reduces interference and makes the signals easier to listen to.

**A good quality A1 emission should be free of any spurious emissions and have a pure note.**

A good quality A1 emission should be free of any \_\_\_\_\_  
\_\_\_\_\_ and have a pure note.

spurious emissions

23. What type of emission is an interrupted, unmodulated carrier wave?

- A. A1.
- B. A2.
- C. F1.
- D. F2.
- E. A $\phi$ .

A

24. What type of emission is a steady, unmodulated carrier wave?

- A. A2.
- B. A $\phi$ .
- C. A1.
- D. F1.
- E. F $\phi$ .

B

25. A transmitter may be keyed (turned on and off) in many ways. One method is to key the oscillator. This method is not desirable since it usually causes the oscillator frequency to change slightly, which causes chirp.

**The best method of keying is to key a stage after the oscillator circuit.**

Keying a stage after the oscillator helps prevent frequency changes and ensures that the transmitter is completely on or off.

The best method of keying is to key a stage \_\_\_\_\_ the \_\_\_\_\_ circuit.

after oscillator

26. Which of the following is characteristic of a good quality A1 emission?

- A. The emission should have many spurious emissions and a pure note.
- B. The emission should have much chirp and a pure note.
- C. The emission should have many clicks and a pure note.
- D. The emission should be free of any spurious emissions and have a pure note.
- E. None of the above.

D

27. What type of emission is an interrupted, unmodulated carrier wave?

- A. A0.
- B. A2.
- C. A1.
- D. F1.
- E. F2.

C

28. To make sure your transmitted signal is clean of spurious emissions, you should make regular checks.

**The best method of checking your transmitted signal is to use an oscilloscope or a good quality receiver.**

The oscilloscope is recommended over a receiver since it gives a visual display of the signal. Also, a receiver located anywhere near the transmitter is easily overloaded by the strong signal and can give a false representation of the actual signal.

The best method of checking your transmitted signal is to use an \_\_\_\_\_ or a good quality \_\_\_\_\_.

oscilloscope receiver

29. Which of the following is the best place to key a transmitter?

- A. The oscillator circuit.
- B. A stage in front of the oscillator circuit.
- C. A stage after the oscillator circuit.
- D. Any of the above.
- E. None of the above.

C

**30.** Which of the following is characteristic of a good quality A1 emission?

- A. The emission should have many spurious emissions and a pure note.
- B. The emission should be free of spurious emissions and have a pure note.
- C. The emission should have many clicks and a pure note.
- D. The emission should have much chirp and a pure note.
- E. None of the above.

B

**31.** The Rules and Regulations state that the frequency of an emitted carrier wave must be as constant as the state of the art permits.

The reason for the above rule is to prevent interference with other communications. Also, amateurs must keep their radio equipment up to the latest standards.

The frequency of an emitted carrier wave must be as \_\_\_\_\_ as the state of the art permits.

constant

**32.** Which of the following is the best method of checking your transmitted signal?

- A. Use a communications-type receiver.
- B. Use an amateur band receiver.
- C. Use an oscilloscope.
- D. Use reception reports from another station.
- E. Any of the above.

C



33. Which of the following is the best place to key a transmitter?

- A. A stage after the oscillator circuit.
- B. The oscillator circuit.
- C. A stage in front of the oscillator circuit.
- D. The antenna.
- E. The main power supply.

A

34. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

- A. The carrier wave may vary in frequency as long as it stays within an amateur band.
- B. The carrier wave may vary in frequency as long as it begins within an amateur band.
- C. The carrier wave may vary in frequency as long as it ends up within an amateur band.
- D. The carrier wave must be as constant as the state of the art permits.
- E. None of the above.

D

35. Which of the following is the best method of checking your transmitted signal?

- A. Use an amateur band receiver.
- B. Use a communications-type receiver.
- C. Use an oscilloscope.
- D. Use reception reports from other stations.
- E. None of the above.

C



**36.** Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

- A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
- B. The carrier wave must be as constant as the state of the art permits.
- C. The carrier wave may vary in frequency as long as it starts within an amateur band.
- D. The carrier wave may vary in frequency as long as it stays within an amateur band.
- E. None of the above.

B

Proceed to the audio review of "The RST System of Reporting" (Tape 1, Side B).

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than two questions, go back and reread this whole module.
- If you have less than two incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame). Then proceed to the next module.

**1. Select the best definition of a spurious emission.**

- A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
- B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
- C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
- E. None of the above.

**2. Select the best definition of a key click.**

- A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
- B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
- C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
- D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
- E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

3. Select the best definition of chirp.

- A. Chirp is the name given a CW signal which changes slowly in frequency.
- B. Chirp is the name given a CW signal which changes quickly in frequency.
- C. Chirp is the name given an audio signal which changes slowly in frequency.
- D. Chirp is the name given an audio signal which changes quickly in frequency.
- E. All of the above.

4. Select the best definition of carrier frequency.

- A. Carrier frequency is always the frequency of the oscillator.
- B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
- C. Carrier frequency is always the frequency of the first multiplier stage.
- D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
- E. Carrier frequency is a spurious emission.

5. Select the best definition of frequency drift.

- A. Frequency drift is a fast change in the frequency of a signal.
- B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
- C. Frequency drift is the same thing as chirp.
- D. Frequency drift is a slow change in the frequency of a signal.
- E. None of the above.

6. Select the best definition of continuous waves.

- A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
- B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
- C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.

- D. Continuous waves are interrupted radio waves that are not modulated.
  - E. Continuous waves are radio waves that have a constant amplitude and are not modulated.
7. What type of emission is a steady, unmodulated carrier wave?
- A. A2.
  - B. AØ.
  - C. A1.
  - D. F1.
  - E. FØ.
8. What type of emission is an interrupted, unmodulated carrier wave?
- A. AØ.
  - B. A2.
  - C. A1.
  - D. F1.
  - E. F2.
9. Which of the following is characteristic of a good quality A1 emission?
- A. The emission should have many spurious emissions and a pure note.
  - B. The emission should be free of spurious emissions and have a pure note.
  - C. The emission should have many clicks and a pure note.
  - D. The emission should have much chirp and a pure note.
  - E. None of the above.
10. Which of the following is the best place to key a transmitter?
- A. A stage after the oscillator circuit.
  - B. The oscillator circuit.
  - C. A stage in front of the oscillator circuit.
  - D. The antenna.
  - E. The main power supply.

11. Which of the following is the best method of checking your transmitted signal?
- A. Use an amateur band receiver.
  - B. Use a communications type receiver.
  - C. Use an oscilloscope.
  - D. Use reception reports from other stations.
  - E. None of the above.
12. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?
- A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
  - B. The carrier wave must be as constant as the state of the art permits.
  - C. The carrier wave may vary in frequency as long as it starts within an amateur band.
  - D. The carrier wave may vary in frequency as long as it stays within an amateur band.
  - E. None of the above.



**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	B	(7)
5.	D	(10)
6.	E	(13)
7.	B	(16)
8.	C	(19)
9.	B	(22)
10.	A	(25)
11.	C	(28)
12.	B	(31)



**Individual Learning Program**

**In**

**AMATEUR RADIO**

**(NOVICE LICENSE)**

**5**

**ELECTRICAL  
PRINCIPLES**







# Individual Learning Program

## AMATEUR RADIO (NOVICE LICENSE)

### *Module 5* ELECTRICAL PRINCIPLES ER-3701

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BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When you complete this module, you will be able to select or determine:

1. The definition of current.
2. The definition of electromotive force.
3. The definition of resistance.
4. The definition of capacitance.
5. The definition of inductance.
6. The definition of alternating current.
7. The basic unit of measurement for frequency.
8. The number of hertz in one kilohertz.
9. The number of hertz in one megahertz.
10. The definition of direct current.
11. The definition of voltage drop.
12. The definition of electrical power.
13. The definition of rectification.
14. The definition of a harmonic.
15. The unit of measurement for electromotive force.
16. The unit of measurement for current.
17. The unit of measurement for resistance.
18. The unit of measurement for power.

19. The unit of measurement for inductance.
20. The unit of measurement for capacitance.
21. The meaning of electrical energy.
22. The amount of current in a circuit when you are given the voltage and resistance.
23. The amount of voltage in a circuit when you are given the current and resistance.
24. The amount of power in a circuit when you are given the voltage and current.
25. The total resistance of two or more resistances in series.
26. The total resistance of two or more resistances in parallel.
27. The current through the components in a series circuit.
28. The voltage across the components in a series circuit.
29. The current through the branches of a parallel circuit.
30. The voltage across the branches of a parallel circuit.
31. The meaning of "magnetic field."
32. The meaning of "magnetomotive force."

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare the answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than six questions, read this whole module.
- If you have less than six incorrect answers, you may either study those frames pertaining to the questions you missed (the number in the parentheses following the correct answer refers you to the proper frame) or you can skip this module and proceed to the next module.

**1. Select the best definition of current.**

- A. A difference of potential.
- B. The opposition to the flow of electrons.
- C. The ability to store electrical energy.
- D. The amount of electrons flowing through a circuit.
- E. The ability to store magnetic energy.

**2. Which of the following best describes electromotive force?**

- A. The amount of electrons flowing through a circuit.
- B. A difference potential.
- C. The opposition to the flow of current.
- D. An electron.
- E. An atom.

**3. Which of the following best describes resistance?**

- A. A difference of potential.
- B. The ability to store electrical energy.
- C. The ability to store magnetic energy.
- D. An electromotive force.
- E. The opposition to the flow of current.

4. Select the best definition of capacitance.
- A. The ability to store electrical energy.
  - B. The ability to store magnetic energy.
  - C. A difference of potential.
  - D. The amount of electrons flowing through a circuit.
  - E. The opposition to the flow of current.
5. Which of the following best describes inductance?
- A. The ability to store electrical energy.
  - B. The ability to store magnetic energy.
  - C. The opposition to the flow of current.
  - D. A difference of potential.
  - E. The amount of electrons flowing through a circuit.
6. Select the best definition of alternating current.
- A. A current flow that changes direction at a given rate.
  - B. A current flow that always flows in one direction.
  - C. A frequency modulated wave.
  - D. An amplitude modulated wave.
  - E. None of the above.
7. Which of the following is the basic unit of measurement for frequency?
- A. The kilohertz.
  - B. The kilocycle.
  - C. The megacycle.
  - D. The hertz.
  - E. The megahertz.
8. How many hertz are in one kilohertz?
- A. 10.
  - B. 100.
  - C. 1000.
  - D. 1,000,000.
  - E. 1.

9. How many hertz are in one megahertz?
- A. 1.
  - B. 10.
  - C. 100.
  - D. 1000.
  - E. 1,000,000.
10. Which of the following best describes direct current?
- A. A current flow that changes direction at a given rate.
  - B. A current flow that always travels in a straight line.
  - C. A current flow that comes straight from the source.
  - D. A current flow that always flows in one direction.
  - E. None of the above.
11. Select the best definition of voltage drop.
- A. A change in voltage due to a short circuit.
  - B. A change in voltage due to an open circuit.
  - C. The voltage that appears only across an inductance.
  - D. The voltage that appears only across a capacitance.
  - E. The voltage that appears across any component in a circuit.
12. Which of the following best describes electrical power?
- A. A difference of potential.
  - B. The rate at which current does work.
  - C. The ability to store electrical energy.
  - D. The ability to store magnetic energy.
  - E. The ability of a circuit to change AC to DC.
13. Select the best definition of rectification.
- A. The process of changing AC into DC.
  - B. The ability to change inductance into capacitance.
  - C. The ability to change capacitance into inductance.
  - D. The ability to correct a problem.
  - E. The process of changing DC into AC.

14. Which of the following best describes a harmonic?
- A. A frequency that is less than an original frequency.
  - B. A frequency that is a whole multiple of an original frequency.
  - C. A frequency that is an even multiple of another frequency.
  - D. A frequency that is an odd multiple of another frequency.
  - E. A frequency that is a fraction of another frequency.
15. What is the unit of measurement for electromotive force?
- A. The farad.
  - B. The ampere.
  - C. The henry.
  - D. The volt.
  - E. The ohm.
16. What is the unit of measurement for current?
- A. The watt.
  - B. The ohm.
  - C. The volt.
  - D. The henry.
  - E. The ampere.
17. What is the unit of measurement for resistance?
- A. The farad.
  - B. The ohm.
  - C. The ampere.
  - D. The henry.
  - E. The watt.
18. What is the unit of measurement for power?
- A. The ampere.
  - B. The watt.
  - C. The volt.
  - D. The farad.
  - E. The ohm.



19. What is the unit of measurement for inductance?

- A. The farad.
- B. The ampere.
- C. The hertz.
- D. The watt.
- E. The henry.

20. What is the unit of measurement for capacitance?

- A. The watt.
- B. The hertz.
- C. The ampere.
- D. The farad.
- E. The henry.

21. Which of the following best describes electrical energy?

- A. The ability to store electrical work.
- B. The ability to store magnetic work.
- C. The ability to dissipate work.
- D. The ability to store voltage.
- E. The ability to do electrical work.

22. How much current flows in the circuit shown below?



- A. 2 amperes.
- B. 50 amperes.
- C. 0.5 amperes.
- D. 5 amperes.
- E. 10 amperes.

23. What is the battery voltage in the circuit shown below?



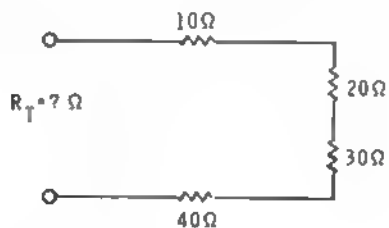
- A. 33.3 volts.
- B. .03 volts.
- C. 3000 volts.
- D. 300 volts.
- E. 3 volts.

24. How much power is used in the circuit shown below?



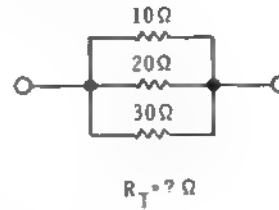
- A. 500 watts.
- B. 250 watts.
- C. 50 watts.
- D. 10 watts.
- E. 2 watts.

25. What is the total resistance of the circuit shown below?

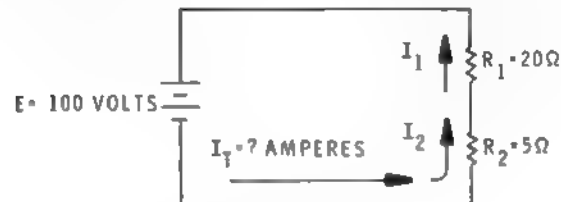


- A. 100  $\Omega$ .
- B. .208  $\Omega$ .
- C. 2.5  $\Omega$ .
- D. 1000  $\Omega$ .
- E. 10  $\Omega$ .

26. What is the total resistance of the following circuit?



- A.  $6.667\ \Omega$ .
  - B.  $60\ \Omega$ .
  - C.  $7.5\ \Omega$ .
  - D.  $12\ \Omega$ .
  - E.  $5.45\ \Omega$ .
27. How much current flows through resistor  $R_2$  in the following circuit?

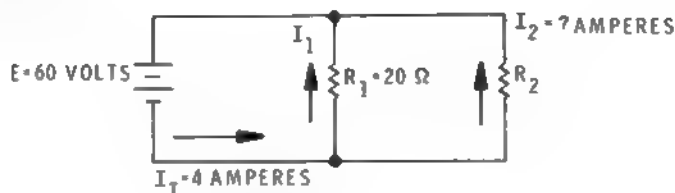


- A. 5 amperes.
  - B. 4 amperes.
  - C. 20 amperes.
  - D. 25 amperes.
  - E. Can't determine from information given.
28. What is the battery voltage in the following circuit?

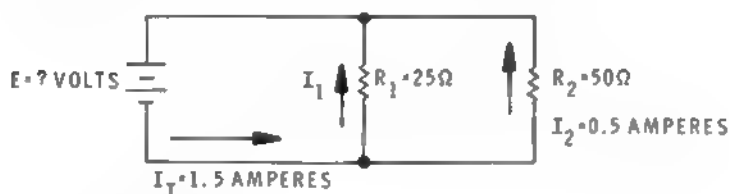


- A. Can't be determined.
- B. 45 volts.
- C. 150 volts.
- D. 105 volts.
- E. 31.5 volts.

29. How much current flows through resistor  $R_2$  in the following circuit?



- A. Can't be determined.
  - B. 1 ampere.
  - C. 4 amperes.
  - D. 3 amperes.
  - E. 12 amperes.
30. What is the battery voltage in the following circuit?



- A. 75 volts.
  - B. 37.5 volts.
  - C. 100 volts.
  - D. 112.5 volts.
  - E. 25 volts.
31. Select the best definition of a magnetic field.
- A. A magnetic field is produced by the invisible lines of force that surround a magnet.
  - B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
  - C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
  - D. A magnetic field is formed by the visible lines of force that surround a magnet.
  - E. None of the above.

32. Select the best definition of magnetomotive force.

- A. Magnetomotive force is a force which reduces a magnetic field.
- B. Magnetomotive force is a force which produces a magnetic field.
- C. Magnetomotive force is a force that is only produced by magnetic material.
- D. Magnetomotive force is a force that is only produced by an electromagnet.
- E. Magnetomotive force is the invisible lines of force that surround a magnet.

### PRETEST ANSWERS

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>	<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D.	(1)	17.	B.	(46)
2.	B.	(2)	18.	B.	(49)
3.	E.	(4)	19.	E.	(52)
4.	A.	(7)	20.	D.	(55)
5.	B.	(10)	21.	E.	(58)
6.	A.	(13)	22.	A.	(61)
7.	D.	(16)	23.	D.	(64)
8.	C	(19)	24.	B.	(67)
9.	E.	(22)	25.	A.	(70)
10.	D.	(25)	26.	E.	(73)
11.	E.	(28)	27.	B.	(76)
12.	B.	(31)	28.	C.	(79)
13.	A.	(34)	29.	B.	(82)
14.	B.	(37)	30.	E.	(85)
15.	D.	(40)	31.	A.	(88)
16.	E.	(43)	32.	B.	(91)

## INTRODUCTION

In this module about electrical principles, you will learn the terms and concepts associated with simple electronic circuits. You will also learn some basic theory and mathematical calculations concerning series and parallel circuits. Last, you will learn some fundamental laws of magnetism.

## PROGRAMMED INSTRUCTION

1. All matter is made up of tiny particles called "atoms." Atoms are further broken down into even smaller particles called "protons," "neutrons," and "electrons." Controlling electrons is the main function of all electronic circuits.

**Current is the amount of electrons flowing through a circuit.**

As you will learn later, the amount of current flow depends upon the pressure applied to the circuit and the amount of resistance the circuit has.

Current is the amount of \_\_\_\_\_ flowing through a circuit.

electrons

2. Electromotive force (EMF) is a difference of potential.

Electromotive force can be thought of as the "pressure" needed to push electrons through a circuit. This pressure is expressed as a voltage and can be produced by a battery, a generator, etc.

Figure 5-1 shows two simple circuits. Each circuit contains a battery and a wire. Note that the larger the battery, the larger the amount of current flow through the wire. Also note that electrons flow from the negative (-) end of the battery to the positive (+) end of the battery.

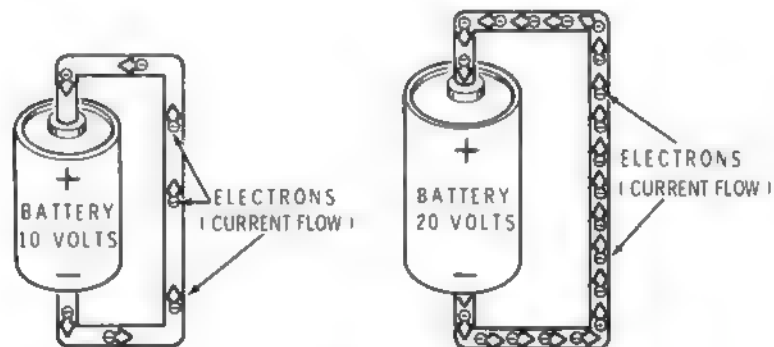


Figure 5-1

Electromotive force (EMF) is a \_\_\_\_\_ of \_\_\_\_\_.

difference      potential

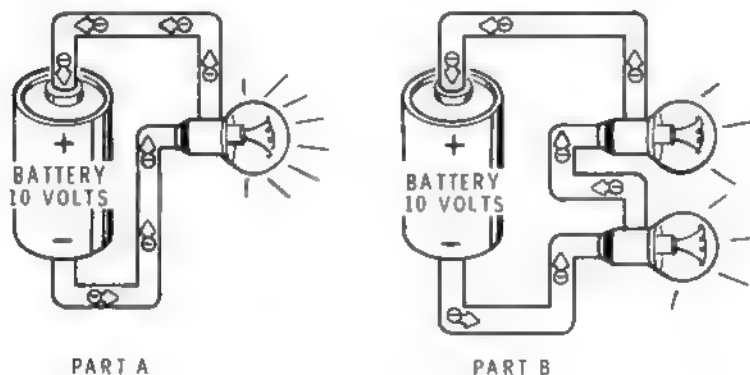
3. Select the best definition of current.

- A. Current is the amount of electrons flowing through a circuit.
- B. Current is the opposition to the flow of electrons.
- C. Current is a difference of potential.
- D. Current is the same as pressure.
- E. Current is an electromotive force.

A

**4. Resistance is the opposition to the flow of current.**

If you insert a light bulb in the simple circuit mentioned earlier (see Figure 5-2, Part A), you have opposition to the flow of current through the circuit. If you add another bulb to the circuit, the opposition becomes greater (see Part B).



**Figure 5-2**

Resistance is the \_\_\_\_\_ to the flow of current.

opposition

**5. Select the best definition of electromotive force.**

- A. Electromotive force is the amount of current that flows through a circuit.
- B. Electromotive force is the amount of electrons that flow through a circuit.
- C. Electromotive force is a difference of potential.
- D. Electromotive force is the weight of electrons.
- E. Electromotive force is the size of a group of electrons.

C



6. "The amount of electrons flowing through a circuit" is the definition for which of the following?

- A. Electromotive force.
- B. Resistance.
- C. Capacitance.
- D. Current.
- E. Voltage.

D

7. Capacitance is a measurement of the ability to store electrical energy.

A capacitor is formed by two conductive plates which are separated by an insulator. The size of the plates mainly determines the amount of capacitance, although the kind of insulator and the spacing between the plates also affect it.

Capacitance is a \_\_\_\_\_ of the ability to store \_\_\_\_\_ energy.

measurement      electrical

8. Select the best definition of resistance.

- A. Resistance is the opposition to the flow of current.
- B. Resistance is the amount of electrons flowing through a circuit.
- C. Resistance is a difference of potential.
- D. Resistance is a measurement of the ability to store electrical energy.
- E. Resistance is the same as pressure.

A

9. "A difference of potential" is the definition for which of the following?

- A. Current.
- B. Electromotive force.
- C. Resistance.
- D. An electron.
- E. An atom.

B

10. Inductance is a measurement of the ability to store magnetic energy.

An inductor is formed by a coil of wire. The diameter, length, and number of turns of the coil determine the amount of inductance. The proximity to a nearby conductor also has an effect on a coil's inductance.

Inductance is a \_\_\_\_\_ of the ability to store \_\_\_\_\_ energy.

measurement      magnetic

11. Select the best definition of capacitance.

- A. Capacitance is a measurement of a difference of potential.
- B. Capacitance is a measurement of the ability to store mechanical energy.
- C. Capacitance is a measurement of the ability to store electrical energy.
- D. Capacitance is the opposition to the flow of current.
- E. Capacitance is the amount of voltage in a circuit.

C

12. "The opposition to the flow of current" is the definition for which of the following?

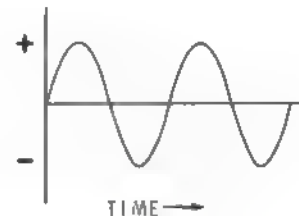
- A. Voltage.
- B. Capacitance.
- C. Inductance.
- D. Electromotive force.
- E. Resistance.

E.

13. **Alternating current (AC) is a current flow that changes direction at a given rate.**

AC is caused by a voltage source that alternately changes polarity ("+" terminal changes to "-", "-" terminal changes to "+", etc.). The rate at which the current changes directions is called the frequency. Figure 5-4 shows an AC wave that changes polarity at regular intervals.

Figure 5-4



Alternating current (AC) is a \_\_\_\_\_ flow that changes \_\_\_\_\_ at a given rate.

current      direction

14. Select the best definition of inductance.

- A. Inductance is a measurement of the ability to store electrical energy.
- B. Inductance is a measurement of the ability to store magnetic energy.
- C. Inductance is a measurement of a difference of potential.
- D. Inductance is the opposition to the flow of current.
- E. Inductance is a measurement of the current used in a circuit.

B

15. "The ability to store electrical energy" is the definition for which of the following?

- A. Capacitance.
- B. Inductance.
- C. Potential difference.
- D. Current.
- E. Resistance.

A

16. The hertz (Hz) is the basic unit of measurement for frequency, and it equals 1 cycle per second.

One cycle per second (see Figure 5-5) means that a wave makes a complete alternation in one second of time.

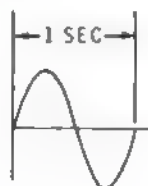


Figure 5-5

The hertz (Hz) is the basic unit of measurement for \_\_\_\_\_, and it equals one \_\_\_\_\_ per \_\_\_\_\_.

frequency    cycle    second

17. Which of the following is the best definition of alternating current (AC)?

- A. Alternating current is a current flow that changes from AC to DC at a given rate.
- B. Alternating current is a flow of voltage that changes direction at a given rate.
- C. Alternating current is a current flow that flows in one direction.
- D. Alternating current (AC) is a current flow that changes direction at a given rate.
- E. Alternating current is a current flow that is interrupted.

D

18. "The ability to store magnetic energy" is the definition for which of the following?

- A. Capacitance.
- B. Inductance.
- C. Resistance.
- D. Potential difference.
- E. Current.

B

19. A kilohertz (kHz) is 1000 hertz (1000 cycles per second).

A kilohertz is \_\_\_\_\_ hertz.

1000

20. What is the basic unit of measurement for frequency that equals 1 cycle per second called?

- A. The kilohertz.
- B. The megahertz.
- C. The hertz.
- D. The kilocycle.
- E. The megacycle.

C

21. "A current flow that changes direction at a given rate" is the definition for which of the following?

- A. Alternating current.
- B. Direct current.
- C. Frequency modulation.
- D. Amplitude modulation.
- E. None of the above.

A

22. A megahertz (MHz) is 1,000,000 hertz (1,000,000 cycles per second).

A megahertz is \_\_\_\_\_ hertz.

1,000,000

23. How many hertz is 1 kilohertz?

- A. 1.
- B. 100.
- C. 10.
- D. 10,000.
- E. 1000.

E

**24.** Select the basic unit of measurement for frequency.

- A. The kilohertz.
- B. The kilocycle.
- C. The megacycle.
- D. The hertz.
- E. The megahertz.

D

**25.** Direct current (DC) is a current flow that always travels in one direction.

DC is caused by a voltage source whose polarity ("+" terminal and "-" terminal) always stays the same. A battery is a common example of a direct current source.

Direct current (DC) is a \_\_\_\_\_ flow that always travels in \_\_\_\_\_ direction.

current      one

**26.** How many hertz is 1 megahertz?

- A. 1000.
- B. 1,000,000.
- C. 10.
- D. 100.
- E. 100,000.

B

27. 1000 hertz is equal to how many kilohertz?

- A. 10.
- B. 100.
- C. 1000.
- D. 1,000,000.
- E. 1.

E

28. The voltage that appears across a component (or group of components) in a circuit is called voltage drop.

Voltage drop is proportional to the resistance of a component multiplied by the current flowing through it.

The voltage that appears across a component (or group of components) in a circuit is called \_\_\_\_\_.

voltage drop

29. Which of the following is the best definition of direct current (DC)?

- A. Direct current is a current flow that changes direction at a given rate.
- B. Direct current is a current flow that changes from AC to DC at a given rate.
- C. Direct current is a current flow that always travels in one direction.
- D. Direct current is a current flow that comes directly from a source.
- E. Direct current is a current flow that flows in a straight line.

C



**30.** 1,000,000 hertz is equal to how many megahertz?

- A. 1.
- B. 10.
- C. 100.
- D. 1000.
- E. 1,000,000.

A

**31.** Electrical power is the rate at which current does work.

Since the FCC limits the power level of all transmitters, electrical power is an important consideration in the operation of an amateur station.

Electrical power is the \_\_\_\_\_ at which current does \_\_\_\_\_.

rate      work

**32.** Which of the following is the best definition of voltage drop?

- A. Voltage drop is the voltage that flows through a component in a circuit.
- B. Voltage drop is the voltage that a component in a circuit uses.
- C. Voltage drop is a reduction in voltage caused by a change in battery voltage.
- D. Voltage drop is the voltage that appears across a component in a circuit.
- E. None of the above.

D

33. "A current flow that always travels in one direction" is the definition for which of the following?

- A. AC.
- B. Straight-line current.
- C. Alternating current.
- D. Direct current.
- E. None of the above.

D

34. Since most electronic circuits require direct current (DC) and ordinary house current is alternating current (AC), some process must be used to convert the AC into DC.

**The process of changing AC into DC is called "rectification."**

The next Module will cover rectification in greater detail.

The process of changing \_\_\_\_\_ into \_\_\_\_\_ is called rectification.

AC      DC

35. Which of the following is the best definition of electrical power?

- A. Electrical power is a current flow that changes direction at a given rate.
- B. Electrical power is the rate at which current does work.
- C. Electrical power is a current flow that always travels in one direction.
- D. Electrical power is the same thing as ordinary house current.
- E. Electrical power is the type of current you get only from a battery.

B

36. "The voltage that appears across a component in a circuit" is the definition for which of the following?

- A. Alternating current.
- B. Direct current.
- C. Inductance.
- D. Capacitance.
- E. Voltage drop.

E

37. A harmonic is a multiple of a frequency.

Harmonics are always a whole multiple ( $2\times$ ,  $3\times$ ,  $4\times$ , etc.) of a given frequency. The second harmonic of 7 megahertz, for example is 14 megahertz.

A harmonic is a \_\_\_\_\_ of a frequency.

multiple

38. Which of the following is the best definition of rectification?

- A. Rectification is the process of changing DC into AC.
- B. Rectification is the process of changing voltage into current.
- C. Rectification is the process of changing AC into DC.
- D. Rectification is the process of changing current into voltage.
- E. Rectification is the process of changing capacitance into inductance.

C

**39.** "The rate at which current does work" is the definition for which of the following?

- A. Potential difference.
- B. Electrical power.
- C. Inductance.
- D. Capacitance.
- E. Rectification.

B

**40.** The unit of measurement of electromotive force (EMF) is the "volt."

Electromotive force is usually expressed in volts, millivolts, or microvolts.

The unit of measurement of electromotive force (EMF) is the \_\_\_\_\_.

volt

**41.** Which of the following is/are true of a harmonic?

- A. A harmonic is a whole multiple of a frequency.
- B. A harmonic is an odd multiple of a frequency.
- C. A harmonic is an even multiple of a frequency.
- D. A harmonic is an even or an odd multiple of a frequency.
- E. All of the above.

F

**42.** "The process of changing AC into DC" is the definition for which of the following?

- A. Rectification.
- B. Inductance.
- C. Capacitance.
- D. Potential difference.
- E. Alternating current.

A

**43.** The unit of measurement of current is the "ampere."

Current is usually expressed in amperes, milliamperes, or microamperes.

The unit of measurement of current is the \_\_\_\_\_.

ampere

**44.** Which of the following is the unit of measurement for electromotive force (EMF)?

- A. The ampere.
- B. The ohm.
- C. The hertz.
- D. The volt.
- E. The farad.

D

45. Which of the following is true concerning a harmonic?

- A. A harmonic is always less than the original frequency.
- B. A harmonic is a whole multiple of a frequency.
- C. A harmonic is never an even multiple of a frequency.
- D. A harmonic is never an odd multiple of a frequency.
- E. A harmonic is a fraction of a frequency.

B

46. The unit of measurement of resistance is the "ohm."

Resistance is expressed in ohms, kilohms, or megohms.

The unit of measurement of resistance is the \_\_\_\_\_.

ohm

47. Which of the following is the unit of measurement for current?

- A. The farad.
- B. The volt.
- C. The ampere.
- D. The ohm.
- E. The hertz.

C

48. The volt is the unit of measurement for which of the following?

- A. Capacitance.
- B. Current.
- C. Inductance.
- D. Electromotive force (EMF).
- E. Resistance.

D

**49. The unit of measurement for power is the "watt."**

Power is usually expressed in watts, milliwatts, microwatts, and kilowatts.

The unit of measurement for power is the \_\_\_\_\_.

watt

**50. Which of the following is the unit of measurement for resistance?**

- A. The ohm.
- B. The mho.
- C. The volt.
- D. The watt.
- E. The ampere.

A

**51. The ampere is the unit of measurement for which of the following?**

- A. Power.
- B. Resistance.
- C. Electromotive force (EMF).
- D. Inductance.
- E. Current.

E

**52. The unit of measurement for inductance is the "henry."**

Inductance is usually measured in henries, millihenries, or microhenries.

The unit of measurement for inductance is the \_\_\_\_\_.

henry

**53. Which of the following is the unit of measurement for power?**

- A. The volt.
- B. The ohm.
- C. The watt.
- D. The henry.
- E. The ampere.

C

**54. The ohm is the unit of measurement for which of the following?**

- A. Capacitance.
- B. Resistance.
- C. Current.
- D. Inductance.
- E. Power.

B

**55. The unit of measurement for capacitance is the "farad."**

Capacitance is usually measured in microfarads or picofarads.

The unit of measurement for capacitance is the \_\_\_\_\_.

farad



56. Which of the following is the unit of measurement for inductance?

- A. The farad.
- B. The watt.
- C. The ohm.
- D. The henry.
- E. The ampere.

D

57. The watt is the unit of measurement for which of the following?

- A. Current.
- B. Power.
- C. Electromotive force (EMF).
- D. Capacitance.
- E. Resistance.

B

58. The potential, or ability, to do electrical work is known as "electrical energy." For example, a battery is a source of electrical energy because it has the ability to do electrical work.

Electrical energy is similar to power. The main difference is that power is a measure of the amount of work done in a specific period of time.

The amount of electrical work that is available is called \_\_\_\_\_.

electrical energy

59. Which of the following is the unit of measurement for capacitance?

- A. The farad.
- B. The henry.
- C. The volt.
- D. The hertz.
- E. The ohm.

A

60. The henry is the unit of measurement for which of the following?

- A. Capacitance.
- B. Current.
- C. Frequency.
- D. Power.
- E. Inductance.

E

61. Ohm's law states that "current is directly proportional to voltage and inversely proportional to resistance.

Usually, the letter  $I$  represents current,  $E$  represents voltage, and  $R$  represents resistance. Therefore, according to Ohm's law,

$$I = \frac{E}{R}$$

Assume that you have the simple circuit shown below and you want to determine how much current flows through it. (Note the symbols for a battery and resistance.)



SOLUTION:

$$\text{Since } I = \frac{E}{R}, \quad I = \frac{30 \text{ volts}}{10 \text{ ohms}}$$

$$30 \div 10 = 3 \text{ amperes (answer)}$$

What would the current in the above circuit be if the resistance was 15 ohms? \_\_\_\_\_.

2 amperes (30 volts  $\div$  15 ohms = 2 amperes)

62. What is the potential, or ability, to do electrical work called?

- A. Power.
- B. Capacitance.
- C. Electrical energy.
- D. Electromotive force.
- E. Inductance.

63. The farad is the unit of measurement for which of the following?

- A. Power.
- B. Frequency.
- C. Current.
- D. Capacitance.
- E. Inductance.

D

64. Assume that you have the simple circuit shown below and you want to determine the voltage across it.



SOLUTION: As you learned from Ohm's law,  $I = \frac{E}{R}$ . If you multiply both sides of the equation by  $R$  ( $I \times R = \frac{E}{R} \times R$ ), the  $R$ 's cancel out on the right side of the equation which leaves the equation for voltage:

$$E = I \times R$$

Since  $E = I \times R$ ,  $E = 4 \text{ amperes} \times 5 \text{ ohms}$  (from above problem)

$$4 \times 5 = 20 \text{ volts (answer)}$$

What would the voltage across the above circuit be if the current was 3 amperes? \_\_\_\_\_.

15 volts (3 amperes  $\times$  5 ohms = 15 volts)

65. How much current flows in the circuit shown below?



- A. 100 amperes.
- B. 1 ampere.
- C. 10 amperes.
- D. .1 ampere.
- E. None of the above.

B (10 volts / 10 ohms = 1 ampere)

66. What is the potential, or ability, to do electrical work called?

- A. Capacitance.
- B. Inductance.
- C. Power.
- D. Potential difference.
- E. Electrical energy.

D.

67. Any circuit that contains resistance dissipates power in the form of heat. The amount of this power can be very small or large, depending on the particular circuit.

The equation for power (in watts) is  $P = I \times E$ . The letter  $P$  is usually used to represent power.

How much power is used in the circuit below?



SOLUTION: Since  $P = I \times E$ ,  $P = 10 \text{ amperes} \times 20 \text{ volts}$

$$10 \times 20 = 200 \text{ watts (answer)}$$

How much power would be used in the above circuit if the current was 5 amperes? \_\_\_\_\_.

100 watts (5 amperes  $\times$  20 volts = 100 watts)

68. How much voltage must be across the circuit below to cause the indicated current to flow?



- A. 0.4 volts.
- B. 2.5 volts.
- C. 1 volt.
- D. 100 volts.
- E. 10 volts.

E (2 amperes  $\times$  5 ohms = 10 volts)

69. How much current flows in the circuit shown below?



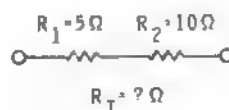
- A. 2 amperes.
- B. 50 amperes.
- C. 0.5 amperes.
- D. 5 amperes.
- E. 10 amperes.

A (10 volts  $\div$  5 ohms = 2 amperes)

70. The circuits covered so far are called series circuits (each component is connected end to end) and contain only one resistance. Actually, there could be any number of resistances (also called "resistors") connected in these series circuits.

To determine the total resistance in a series circuit containing two or more resistors, you simply add the individual resistor values together. Therefore,  $R_{T(\text{total})} = R_1 + R_2 + R_3 + \text{etc.}$

What is the total resistance of the two resistors shown below? (NOTE: For convenience, the Greek letter Omega,  $\Omega$ , is used to indicate ohms.)



SOLUTION: Since  $R_T = R_1 + R_2$ ,  $R_T = 5 \Omega + 10 \Omega$

$$5 \Omega + 10 \Omega = 15 \Omega \text{ (answer)}$$

What is the total resistance of two 10  $\Omega$  resistors connected in series? \_\_\_\_\_.

20  $\Omega$  (10  $\Omega$  + 10  $\Omega$  = 20  $\Omega$ )

71. How much power is used in the circuit shown below?



- A. 50 watts.
- B. 100 watts.
- C. 200 watts.
- D. 5000 watts.
- E. 25 watts.

C (2 amperes  $\times$  100 volts = 200 watts)

72. What value of voltage is across the circuit shown below?



- A. 33.3 volts.
- B. .03 volts.
- C. 3000 volts.
- D. 300 volts.
- E. 3 volts.

D (3 amperes  $\times$  100  $\Omega$  = 300 volts)

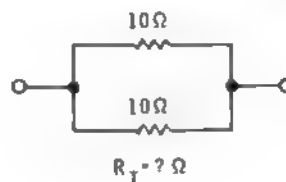


73. In some cases, resistors are connected in parallel instead of in series.

To determine the total resistance in a parallel circuit containing two or more resistors, you use the equation

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{etc.}}$$

What is the total resistance of the two resistors shown below?



SOLUTION: Since  $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$ ,

$$R_T = \frac{1}{\frac{1}{10\ \Omega} + \frac{1}{10\ \Omega}} = \frac{1}{.2}$$

$$\frac{1}{.2} = 5\ \Omega \text{ (answer)}$$

NOTE: The total resistance of two or more resistors connected in parallel is **always** less than the lowest value resistor.

What is the total resistance of a  $10\ \Omega$  and a  $30\ \Omega$  resistor connected in parallel? \_\_\_\_\_.

$$7.5\ \Omega \left( \frac{1}{\frac{1}{10} + \frac{1}{30}} \right) \quad 7.5\ \Omega$$

74. What is the total resistance of three  $20\ \Omega$  resistors connected in series?

- A.  $20\ \Omega$ .
- B.  $60\ \Omega$ .
- C.  $40\ \Omega$ .
- D.  $6.667\ \Omega$ .
- E.  $10\ \Omega$ .

B ( $R_T = 20\ \Omega + 20\ \Omega + 20\ \Omega = 60\ \Omega$ )

75. How much power is used in the circuit shown below?



- A. 500 watts.
- B. 250 watts.
- C. 50 watts.
- D. 10 watts.
- E. 2 watts.

B ( $P = 50\ \text{volts} \times 5\ \text{amperes} = 250\ \text{watts}$ )

76. The same amount of current always flows through each component in a series circuit. This is easy to understand since each component is connected end-to-end throughout the circuit. Therefore, whatever value of current flows through one component must also flow through every other component.

What value of current flows through each resistor in the following circuit?



**SOLUTION:** Before you can determine the current, you must find the total resistance. Since this is a series circuit, the total resistance is  $20\ \Omega$  ( $15\ \Omega + 5\ \Omega$ ).

Now to calculate the current, divide the battery voltage by the total resistance.

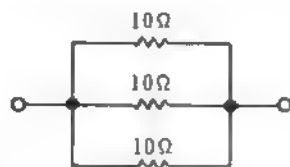
$$I = \frac{E}{R_T} = \frac{40\ \text{volts}}{20\ \Omega} = 2\ \text{amperes (answer)}$$

Since this is a series circuit, this same 2 amperes flows through each resistor.

What value of current would flow through the resistors in the above circuit if the battery voltage was 60 volts? \_\_\_\_\_.

3 amperes ( $60\ \text{volts} \div 20\ \text{ohms} = 3\ \text{amperes}$ )

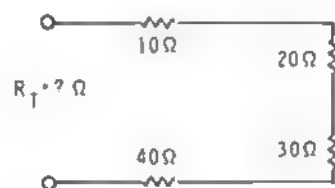
77. What is the total resistance of three  $10\ \Omega$  resistors connected in parallel?



- A.  $10\ \Omega$ .
- B.  $30\ \Omega$ .
- C.  $3.33\ \Omega$ .
- D.  $20\ \Omega$ .
- E.  $33.3\ \Omega$ .

$$C \quad \left( \frac{1}{10} + \frac{1}{10} + \frac{1}{10} \right) = 3.33\ \Omega$$

78. What is the total resistance of the circuit shown below?

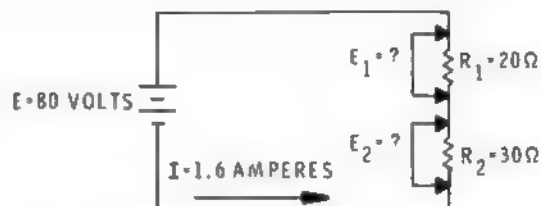


- A.  $100\ \Omega$ .
- B.  $.208\ \Omega$ .
- C.  $2.5\ \Omega$ .
- D.  $1000\ \Omega$ .
- E.  $10\ \Omega$ .

$$A \quad (R_T = 10\ \Omega + 20\ \Omega + 30\ \Omega + 40\ \Omega = 100\ \Omega)$$

79. As you were shown earlier, the same amount of current always flows through each component in a series circuit. The voltage that appears across each component, however, is not the same. The amount of voltage that appears across a resistor in a series circuit is directly proportional to the value of the resistor.

Assume that you have the circuit shown below and you want to determine the voltage across each resistor.



**SOLUTION:** Since the same current (1.6 amperes) flows through each resistor, all you need to do is multiply the current by each resistor value.

$$E_1 = 1.6 \text{ amperes} \times 20 \, \Omega = 32 \text{ volts (voltage across } R_1)$$

$$E_2 = I \times R_2$$

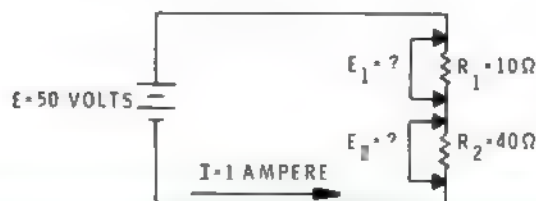
$$E_2 = 1.6 \text{ amperes} \times 30 \, \Omega = 48 \text{ volts (voltage across } R_2)$$

**NOTE:** In series circuit, the voltages across the individual components must add up to the battery voltage ( $E_1 + E_2 = E_{\text{battery}}$ ).

How much voltage is across each resistor in the following circuit?

$$E_1 = \underline{\hspace{2cm}}$$

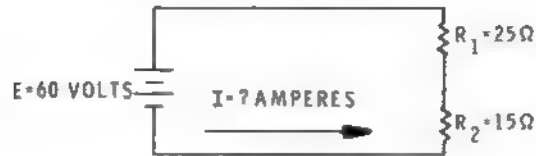
$$E_2 = \underline{\hspace{2cm}}$$



$$E_1 = 10 \text{ volts (} 10 \, \Omega \times 1 \text{ ampere)}$$

$$E_2 = 40 \text{ volts (} 40 \, \Omega \times 1 \text{ ampere)}$$

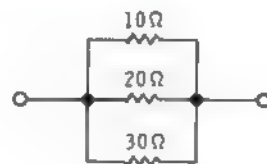
80. How much current flows through each resistor in the following circuit?



- A. 1.5 amperes.
- B. 2.4 amperes.
- C. 4 amperes.
- D. 9.375 amperes.
- E. 0.667 amperes.

$$A \quad (I = \frac{60}{40} = 1.5 \text{ amperes})$$

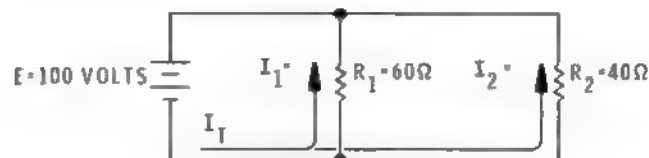
81. What is the total resistance of the following circuit?



- A. 6.667  $\Omega$ .
- B. 60  $\Omega$ .
- C. 7.5  $\Omega$ .
- D. 12  $\Omega$ .
- E. 5.45  $\Omega$ .

$$E \quad (R_t = \frac{1}{\frac{1}{10} + \frac{1}{20} + \frac{1}{30}} = 5.45 \Omega \text{ approximate})$$

82. In contrast to a series circuit, the same amount of current does not necessarily flow through the components in a parallel circuit. As you can see from the circuit below, the current divides before it flows through each branch of the circuit.



What value of current flows through each of the resistors in the above circuit?

**SOLUTION:** Since the battery is connected directly across each resistor, all that is necessary to determine the current through each resistor is simply divide the battery voltage by each resistor value ( $I = \frac{E}{R}$ ).

Therefore,

$$I_1 = \frac{100 \text{ volts}}{60 \Omega} = 1.67 \text{ amperes (current through } R_1).$$

$$I_2 = \frac{100 \text{ volts}}{40 \Omega} = 2.5 \text{ amperes (current through } R_2).$$

To determine the total current (the amount of current the battery supplies), simply add the currents together (1.67 amperes + 2.5 amperes = 4.17 amperes).

As a check, you could determine the total resistance of the two resistors (24  $\Omega$ ) and then divide the battery voltage (100 V) by this total resistance. The current should be the same (4.17 amperes).

How much current would flow through the resistors in the above circuit if the battery voltage was 150 volts?

$$I_1 = \underline{\hspace{2cm}}$$

$$I_2 = \underline{\hspace{2cm}}$$

$$I_1 = 2.5 \text{ amperes } (I_1 = \frac{150}{60} = 2.5 \text{ amperes})$$

$$I_2 = 3.75 \text{ amperes } (I_2 = \frac{150}{40} = 3.75 \text{ amperes})$$

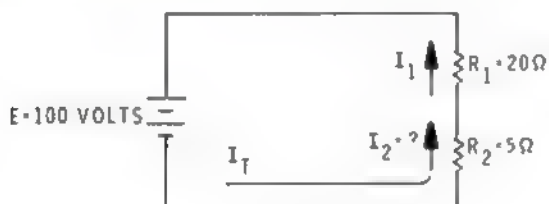
83. How much voltage is across resistor  $R_1$  in the following circuit?



- A. 50 volts.
- B. 100 volts.
- C. 40 volts.
- D. 60 volts.
- E. 24 volts.

D.  $(E = 30 \Omega \times 2 \text{ amperes} = 60 \text{ volts})$

84. How much current flows through resistor  $R_2$  in the following circuit?



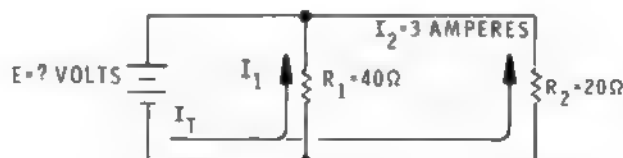
- A. 5 amperes.
- B. 4 amperes.
- C. 20 amperes.
- D. 25 amperes.
- E. Can't be determined with information given.

B

$I_2 = \frac{100}{25} = 4 \text{ amperes.}$  NOTE: Since this is a series circuit, the current is the same everywhere in the circuit.



85. As you were shown in the discussion of the current through a parallel circuit, the same voltage appears across each branch of a parallel circuit. To determine the battery voltage in the following circuit, all that is necessary is to find the voltage across either resistor. What is the battery voltage in the circuit?



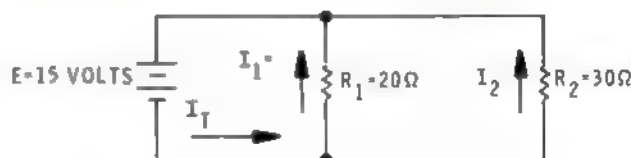
**SOLUTION:** Since the voltage is the same everywhere in a parallel circuit,  $E = E_2$ .  $E_2 = 3 \text{ amperes} \times 20 \Omega = 60 \text{ volts}$ . Therefore,  $E = 60 \text{ volts}$  (answer).

What would the battery voltage be if the current through resistor  $R_2$  was 4 amperes?

$E = \underline{\hspace{2cm}}$

80 volts ( $4 \text{ amperes} \times 20 \Omega = 80 \text{ volts}$ )

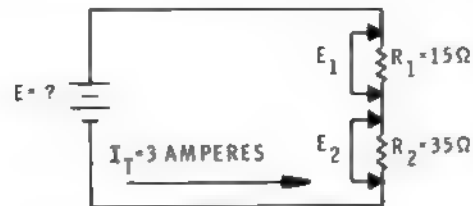
86. How much current flows through resistor  $R_1$  in the following circuit?



- A. 0.3 amperes.
- B. 12 amperes.
- C. 0.5 ampere.
- D. 0.75 ampere.
- E. 1.5 amperes.

D ( $I_1 = \frac{15}{20} = 0.75 \text{ ampere}$ )

87. What is the battery voltage in the following circuit?



- A. Can't be determined.
- B. 45 volts.
- C. 150 volts.
- D. 105 volts.
- E. 31.5 volts.

C ( $E = I \times R_T = 3 \times 50 = 150$  volts)

88. The invisible lines of force that surround a magnet are called a "magnetic field."

This magnetic field is what actually causes two magnets to attract or repel each other. A magnetic field also causes a magnet to attract small pieces of iron or steel.

The invisible lines of force that surround a magnet are called a \_\_\_\_\_.

magnetic field

89. What is the battery voltage in the following circuit?



- A. 150 volts.
- B. 200 volts.
- C. 600 volts.
- D. 800 volts.
- E. Can't be determined.

A (Since only the total current is given, you must first find the total resistance which is  $3.75 \Omega$ . Then you multiply the total current by the total resistance to obtain 150 volts.)

90. How much current flows through resistor  $R_2$  in the following circuit?



- A. Can't be determined.
- B. 1 ampere.
- C. 4 amperes.
- D. 3 amperes.
- E. 12 amperes.

B (First determine the current through  $R_1$ . To do this, divide 60 volts by  $20 \Omega$  and obtain 3 amperes. Since the total current in a parallel circuit must equal the currents through the branches, subtract the current through  $R_1$  from the total current to find the current through  $R_2$ .)

91. The force which produces a magnetic field is called "magnetomotive force."

When a magnet field is produced by an electromagnet, the amount of force is measured in gilberts and is equal to  $1.26 \times$  the number of turns in the coil  $\times$  the current in amperes that is flowing in the coil ( $1.26 \times N \times I$ ).

The force which produces a magnetic field is called \_\_\_\_\_.

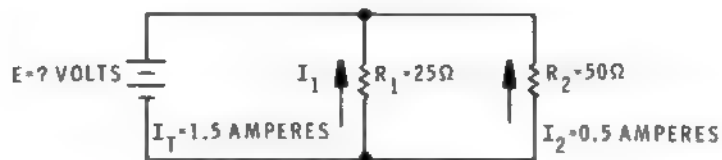
magnetomotive force.

92. Which of the following is the best definition of a magnetic field?

- A. A magnetic field is formed by the visible lines of force that surround a magnet.
- B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
- C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
- D. A magnetic field is formed by the invisible lines of force that surround a magnet.
- E. None of the above.

D

93. What is the battery voltage in the following circuit?



- A. 75 volts.
- B. 37.5 volts.
- C. 100 volts.
- D. 112.5 volts.
- E. 25 volts.

$$E \quad (E = 50 \, \Omega \times 0.5 \text{ amperes} = 25 \text{ volts})$$

94. Which of the following is the best definition of magnetomotive force?

- A. Magnetomotive force is the invisible lines of force that surround a magnet.
- B. Magnetomotive force is the force which reduces a magnetic field.
- C. Magnetomotive force is the force which produces a magnetic field.
- D. Magnetomotive force is a force that is only produced by an electromagnet.
- E. Magnetomotive force is a force that is only produced by a magnetic material.

95. Select the best definition of a magnetic field.

- A. A magnetic field is produced by the invisible lines of force that surround a magnet.
- B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
- C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
- D. A magnetic field is formed by the visible lines of force that surround a magnet.
- E. None of the above.

A

96. Select the best definition of magnetomotive force.

- A. Magnetomotive force is a force which reduces a magnetic field.
- B. Magnetomotive force is a force which produces a magnetic field.
- C. Magnetomotive force is a force that is only produced by magnetic material.
- D. Magnetomotive force is a force that is only produced by an electromagnet.
- E. Magnetomotive force is the invisible lines of force that surround a magnet.

B

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than six questions, go back and re-read this whole module.
- If you have less than six incorrect answers, go back and study those frames pertaining to the questions you missed (the number in the parentheses following the correct answer refers you to the proper frame). Then proceed to the next module.

**1. Select the best definition of current.**

- A. A difference of potential.
- B. The opposition to the flow of electrons.
- C. The ability to store electrical energy.
- D. The amount of electrons flowing through a circuit.
- E. The ability to store magnetic energy.

**2. Which of the following best describes electromotive force?**

- A. The amount of electrons flowing through a circuit.
- B. A difference potential.
- C. The opposition to the flow of current.
- D. An electron.
- E. An atom.

**3. Which of the following best describes resistance?**

- A. A difference of potential.
- B. The ability to store electrical energy.
- C. The ability to store magnetic energy.
- D. An electromotive force.
- E. The opposition to the flow of current.

4. Select the best definition of capacitance.
- A. The ability to store electrical energy.
  - B. The ability to store magnetic energy.
  - C. A difference of potential.
  - D. The amount of electrons flowing through a circuit.
  - E. The opposition to the flow of current.
5. Which of the following best describes inductance?
- A. The ability to store electrical energy.
  - B. The ability to store magnetic energy.
  - C. The opposition to the flow of current.
  - D. A difference of potential.
  - E. The amount of electrons flowing through a circuit.
6. Select the best definition of alternating current.
- A. A current flow that changes direction at a given rate.
  - B. A current flow that always flows in one direction.
  - C. A frequency modulated wave.
  - D. An amplitude modulated wave.
  - E. None of the above.
7. Which of the following is the **basic** unit of measurement for frequency?
- A. The kilohertz.
  - B. The kilocycle.
  - C. The megacycle.
  - D. The hertz.
  - E. The megahertz.
8. How many hertz are in one kilohertz?
- A. 10.
  - B. 100.
  - C. 1000.
  - D. 1,000,000.
  - E. 1.



9. How many hertz are in one megahertz?
- A. 1.
  - B. 10.
  - C. 100.
  - D. 1000.
  - E. 1,000,000.
10. Which of the following best describes direct current?
- A. A current flow that changes direction at a given rate.
  - B. A current flow that always travels in a straight line.
  - C. A current flow that comes straight from the source.
  - D. A current flow that always flows in one direction.
  - E. None of the above.
11. Select the best definition of voltage drop.
- A. A change in voltage due to a short circuit.
  - B. A change in voltage due to an open circuit.
  - C. The voltage that appears only across an inductance.
  - D. The voltage that appears only across a capacitance.
  - E. The voltage that appears across any component in a circuit.
12. Which of the following best describes electrical power?
- A. A difference of potential.
  - B. The rate at which current does work.
  - C. The ability to store electrical energy.
  - D. The ability to store magnetic energy.
  - E. The ability of a circuit to change AC to DC.
13. Select the best definition of rectification.
- A. The process of changing AC into DC.
  - B. The ability to change inductance into capacitance.
  - C. The ability to change capacitance into inductance.
  - D. The ability to correct a problem.
  - E. The process of changing DC into AC.

14. Which of the following best describes a harmonic?
- A. A frequency that is less than an original frequency.
  - B. A frequency that is a whole multiple of an original frequency.
  - C. A frequency that is an even multiple of another frequency.
  - D. A frequency that is an odd multiple of another frequency.
  - E. A frequency that is a fraction of another frequency.
15. What is the unit of measurement for electromotive force?
- A. The farad.
  - B. The ampere.
  - C. The henry.
  - D. The volt.
  - E. The ohm.
16. What is the unit of measurement for current?
- A. The watt.
  - B. The ohm.
  - C. The volt.
  - D. The henry.
  - E. The ampere.
17. What is the unit of measurement for resistance?
- A. The farad.
  - B. The ohm.
  - C. The ampere.
  - D. The henry.
  - E. The watt.
18. What is the unit of measurement for power?
- A. The ampere.
  - B. The watt.
  - C. The volt.
  - D. The farad.
  - E. The ohm.

19. What is the unit of measurement for inductance?
- A. The farad.
  - B. The ampere.
  - C. The hertz.
  - D. The watt.
  - E. The henry.
20. What is the unit of measurement for capacitance?
- A. The watt.
  - B. The hertz.
  - C. The ampere.
  - D. The farad.
  - E. The henry.
21. Which of the following best describes electrical energy?
- A. The ability to store electrical work.
  - B. The ability to store magnetic work.
  - C. The ability to dissipate work.
  - D. The ability to store voltage.
  - E. The ability to do electrical work.
22. How much current flows in the circuit shown below?



- A. 2 amperes.
- B. 50 amperes.
- C. 0.5 amperes.
- D. 5 amperes.
- E. 10 amperes.

23. What is the battery voltage in the circuit shown below?



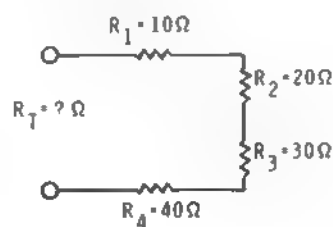
- A. 33.3 volts.
- B. .03 volts.
- C. 3000 volts.
- D. 300 volts.
- E. 3 volts.

24. How much power is used in the circuit shown below?



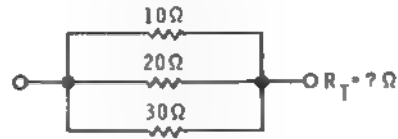
- A. 500 watts.
- B. 250 watts.
- C. 50 watts.
- D. 10 watts.
- E. 2 watts.

25. What is the total resistance of the circuit shown below?

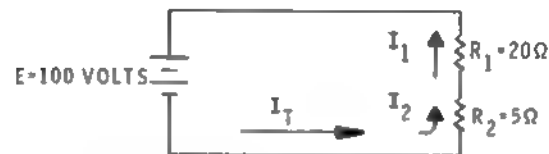


- A. 100  $\Omega$ .
- B. .208  $\Omega$ .
- C. 2.5  $\Omega$ .
- D. 1000  $\Omega$ .
- E. 10  $\Omega$ .

26. What is the total resistance of the following circuit?



- A.  $6.667 \Omega$ .  
 B.  $60 \Omega$ .  
 C.  $7.5 \Omega$ .  
 D.  $12 \Omega$ .  
 E.  $5.45 \Omega$ .
27. How much current flows through resistor  $R_2$  in the following circuit?

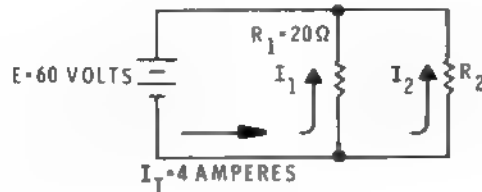


- A. 5 amperes.  
 B. 4 amperes.  
 C. 20 amperes.  
 D. 25 amperes.  
 E. Can't determine from information given.
28. What is the battery voltage in the following circuit?

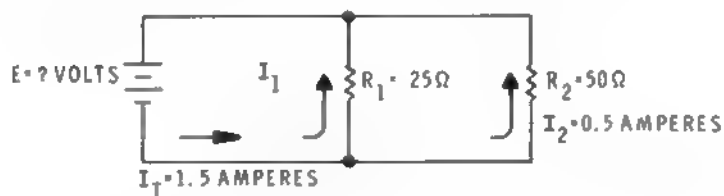


- A. Can't be determined.  
 B. 45 volts.  
 C. 150 volts.  
 D. 105 volts.  
 E. 31.5 volts.

29. How much current flows through resistor  $R_2$  in the following circuit?



- A. Can't be determined.
  - B. 1 ampere.
  - C. 4 amperes.
  - D. 3 amperes.
  - E. 12 amperes.
30. What is the battery voltage in the following circuit?



- A. 75 volts.
- B. 37.5 volts.
- C. 100 volts.
- D. 112.5 volts.
- E. 25 volts.

**31.** Select the best definition of a magnetic field.

- A. A magnetic field is produced by the invisible lines of force that surround a magnet.
- B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
- C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
- D. A magnetic field is formed by the visible lines of force that surround a magnet.
- E. None of the above.

**32.** Select the best definition of magnetomotive force.

- A. Magnetomotive force is a force which reduces a magnetic field.
- B. Magnetomotive force is a force which produces a magnetic field.
- C. Magnetomotive force is a force that is only produced by magnetic material.
- D. Magnetomotive force is a force that is only produced by an electromagnet.
- E. Magnetomotive force is the invisible lines of force that surround a magnet.





**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D.	(1)
2.	B.	(2)
3.	E.	(4)
4.	A.	(7)
5.	B.	(10)
6.	A.	(13)
7.	D.	(16)
8.	C.	(19)
9.	E.	(22)
10.	D.	(25)
11.	E.	(28)
12.	B.	(31)
13.	A.	(34)
14.	B.	(37)
15.	D.	(40)
16.	E.	(43)
17.	B.	(46)
18.	B.	(49)
19.	E.	(52)
20.	D.	(55)
21.	E.	(58)
22.	A.	(61)
23.	D.	(64)
24.	B.	(67)
25.	A.	(70)
26.	E.	(73)
27.	B.	(76)
28.	C.	(79)
29.	B.	(82)
30.	E.	(85)
31.	A.	(88)
32.	B.	(91)



# Individual Learning Program

In

**AMATEUR RADIO**  
(NOVICE LICENSE)





# Individual Learning Program

## AMATEUR RADIO

(NOVICE LICENSE)

*Module 6*

### CIRCUIT COMPONENTS

ER-3701

## MODULE OBJECTIVES

When you complete this module, you will be able to select:

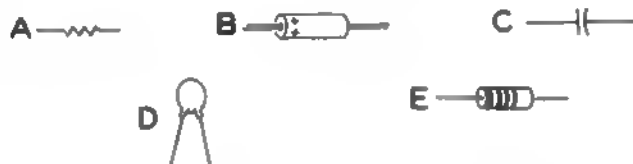
1. The symbol of a resistor.
2. The symbol of a capacitor.
3. The symbol of a crystal.
4. The symbol of an air core and an iron core inductor.
5. The symbol of an air core and an iron core transformer.
6. The symbol of a diode.
7. The symbol of a zener diode.
8. The symbol of a tunnel diode.
9. The symbols of a PNP and an NPN transistor.
10. The symbols of a diode tube, a triode, a tetrode, and a pentode tube.
11. The direction of current flow in a tube.
12. The symbol of a voltmeter.
13. The symbol of an ammeter.
14. The symbol of an ohmmeter.

## MODULE PRETEST

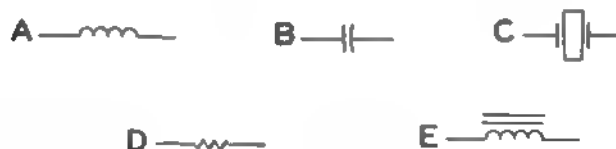
This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than three questions read this whole module.
- If you have less than three incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the next module.

1. Select the symbol of a resistor.



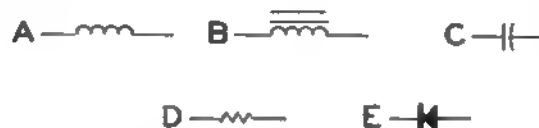
2. Which of the following is the symbol of a capacitor?



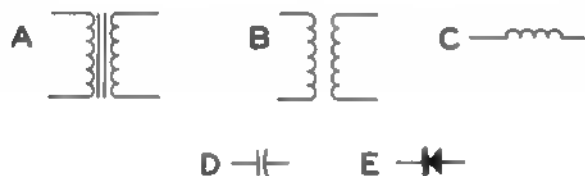
3. Select the symbol of a crystal.



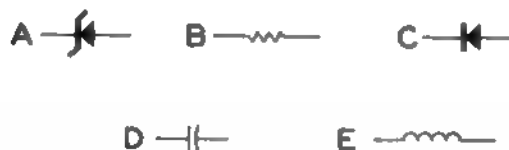
4. Which of the following is the symbol of an iron core inductor?



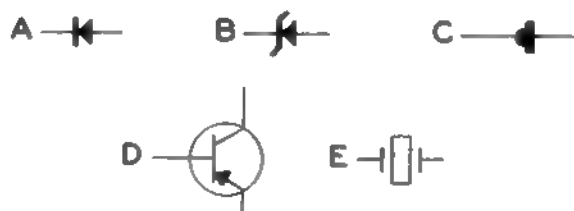
5. Select the symbol of an iron core transformer.



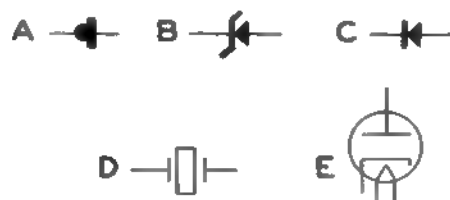
6. Which of the following is the symbol of an ordinary diode?



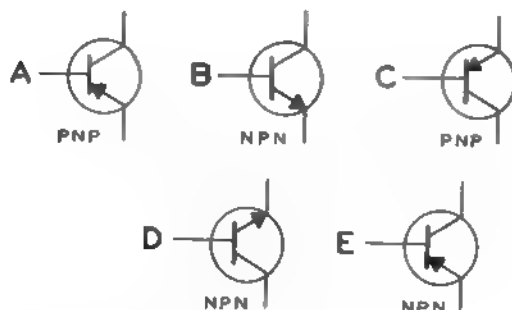
7. Select the symbol of a zener diode.



8. Which of the following is the symbol of a tunnel diode?



9. Select the symbol that is **not** labeled correctly.



10. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode
- D. Tetrode.
- E. Heptode.



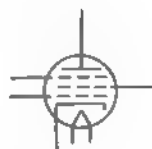
11. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Heptode.



12. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Pentagrid.



13. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Heptode.

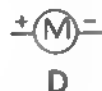
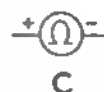
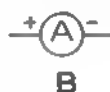




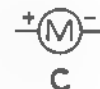
14. Select the true statement concerning the current flow in a vacuum tube.

- A. Current flows from grid to plate.
- B. Current flows from grid to cathode.
- C. Current flows from plate to cathode.
- D. Current flows from cathode to plate.
- E. Current flows from plate to grid.

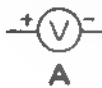
15. Select the symbol of a voltmeter.



16. Select the symbol of an ammeter.



17. Select the symbol of an ohmmeter.



**PRETEST ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	A	(1)
2.	B	(2)
3.	D	(4)
4.	B	(7)
5.	A	(10)
6.	C	(13)
7.	B	(16)
8.	A	(19)
9.	E	(22)
10.	D	(25)
11.	B	(25)
12.	A	(25)
13.	C	(25)
14.	D	(28)
15.	A	(31)
16.	B	(34)
17.	D	(37)

## INTRODUCTION

In an earlier module you learned that abbreviations are used quite often to shorten radio messages. Symbols are used in much the same way to shorten or simplify the wiring diagrams (called schematics) of radio equipment.

This module will teach you the symbols of many common radio components.

## PROGRAMMED INSTRUCTION

1. As you learned earlier, a component which opposes the flow of current is called a resistor.

Figure 6-1, Part A, shows a typical resistor while Part B shows its symbol.



**Figure 6-1**

Resistors often have color bands which give their value in ohms, kilohms, or megohms.

Draw the symbol of a resistor.

2. A component which stores electrical energy is called a capacitor. Capacitors block the flow of direct current (DC) but allow alternating current (AC) to pass.

Figure 6-2, Part A, shows some typical capacitors and Part B shows the basic symbol of a capacitor.

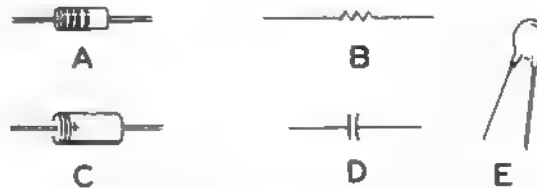


**Figure 6-2**

Capacitors usually have their value in microfarads ( $\mu\text{F}$ ) or picofarads (pF) and their voltage rating printed on them.

Draw the basic symbol of a capacitor.

3. Which of the following is the **symbol** of a resistor?



4. A component which will vibrate at a specific frequency when it is excited is called a crystal. A crystal may be excited by either pressure or a signal. Transmitters and receivers that require high frequency accuracy and stability often use crystal control.

Figure 6-3, Part A, shows a typical crystal and Part B shows its symbol.



**Figure 6-3**

Crystals are usually marked with their oscillation frequency, operating frequency, or channel number.

Draw the symbol of a crystal.

5. Select the symbol of a capacitor.



A



C



B



D



E

6. Which of the following is the symbol of a resistor?



A



B



C



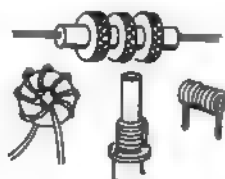
D



E

7. Earlier, you learned what inductance is. A component which exhibits inductance is called an inductor and is usually in the form of a coil.

Inductors have many forms; several of them are shown in Figure 6-4, Part A. Part B shows the symbols for air core and iron core inductors.



PART A



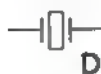
PART B

Figure 6-4

Inductors are measured in henries, millihenries (mH), or microhenries ( $\mu$ H).

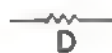
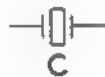
Draw the symbols of an air core and an iron core inductor and label them.

8. Select the symbol of a crystal.



D

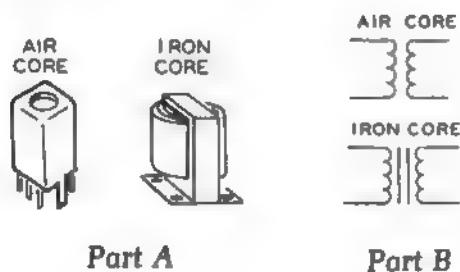
9. Which of the following is the symbol of a capacitor?



B

10. If you place two inductors near each other, you have a transformer. If the two inductors are separated by air, you have an air core transformer. If the two inductors are wound on an iron core, either next to each other or one on top of the other, you have an iron core transformer.

Figure 6-5, Part A, shows two typical transformers. Part B shows the symbol for each type.



**Figure 6-5**

Transformers are usually described by the ratio between the inductors with reference to the number of turns, voltage, current, or impedance (resistance). Transformers are not necessarily limited to two inductors. A color television transformer, for example, could have as many as five separate inductors.

Draw the symbols of an air core and an iron core transformer and label them.



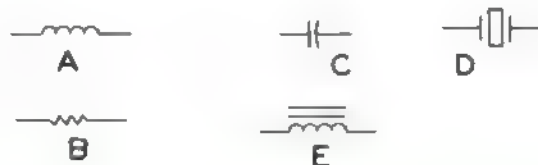


11. Select the symbol of an air core inductor.



A

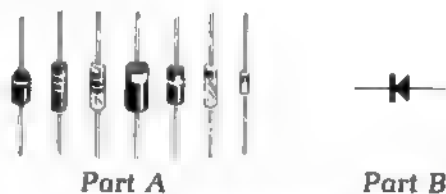
12. Which of the following is the symbol of a crystal?



D

13. A component which has the capability of conducting in only one direction is called a diode. Diodes play an important role in electrical equipment, as you will learn in the next module.

Figure 6-6, Part A, shows some typical diodes, while Part B shows the symbol of a diode.



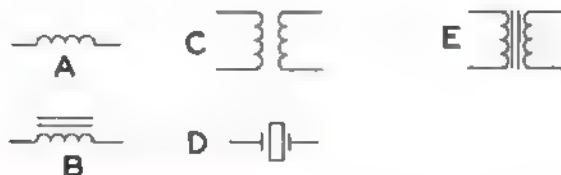
**Figure 6-6**

Diodes are usually specified by type, current rating, and voltage rating.

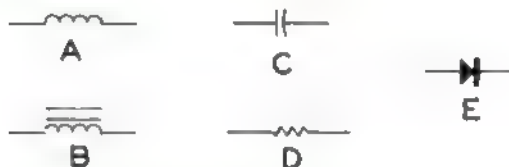
Draw the symbol of a diode.

⏮

14. Select the symbol of an air core transformer.



15. Which of the following is the symbol of an iron core inductor?



16. A diode which has the ability to regulate (hold constant) a voltage is called a zener diode.

A zener diode looks the same physically as the ordinary diode discussed earlier. Figure 6-7 shows the symbol of a zener diode.



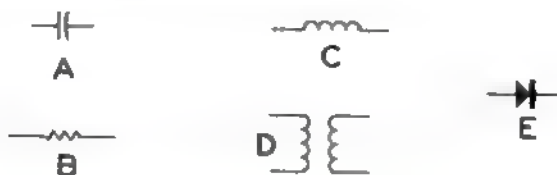
**Figure 6-7**

Zener diodes are usually specified in voltage and wattage.

Draw the symbol of a zener diode.

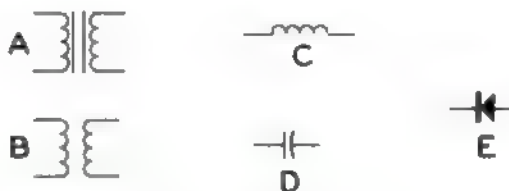


17. Which of the following is the symbol of a diode?



E

18. Select the symbol of an iron core transformer.



A

19. A diode which is capable of operating at high speeds is called a tunnel diode. Due to their high speed, tunnel diodes are often used in electronic switches or high frequency oscillator circuits.

Figure 6-8, Part A, shows a typical tunnel diode and Part B shows its most common symbol.



Figure 6-8

Tunnel diodes are usually specified by their current rating.

Draw the symbol of a tunnel diode.



20. Which of the following is the symbol of a zener diode?



A



C



B



D



E

D

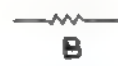
21. Select the symbol of an ordinary diode.



A



C



B



D



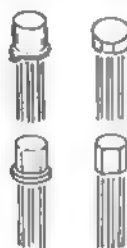
E

C

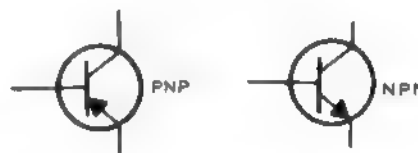
22. Diodes are called semiconductors because they are made from materials which are neither conductors or insulators. Another type of semiconductor is the transistor. The major difference between a transistor and a diode is the transistor's ability to amplify. A transistor usually has three leads (or connections) which are called the emitter, the base, and the collector.

There are two basic types of transistors which are called the PNP type and the NPN type. The use of each type of transistor depends upon the circuit characteristics.

Figure 6-9, Part A, shows some typical transistor packages, while Part B shows the symbol for each transistor type. Note that the only difference between the symbols is the direction of the arrowhead on one of the leads.



Part A



Part B

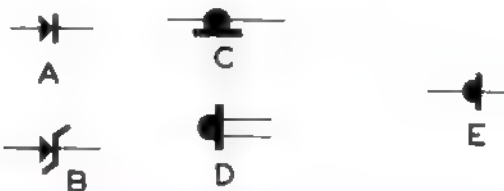
Figure 6-9

Although transistors are specified in many ways, probably the most important quality of a transistor is its gain (amplification).

Draw the symbols of the two types of transistors and label them.

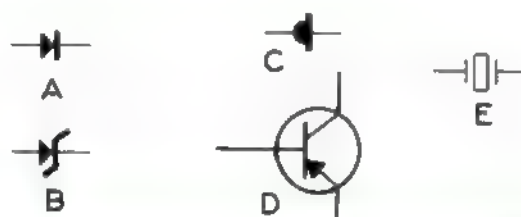


23. Select the symbol of a tunnel diode.



E

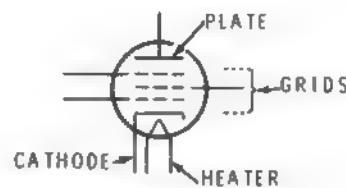
24. Which of the following is the symbol of a zener diode?



B

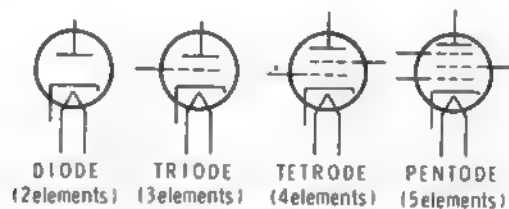
25. Vacuum tubes, more commonly called "tubes," are available in many different forms depending upon their use.

The elements, or parts, of a tube are called the plate, the grid(s), and the cathode. Another part of a tube called the heater (or filament) is not normally classified as an element unless the tube does not have a cathode. Figure 6-10 shows a tube and the name given each part.



**Figure 6-10**

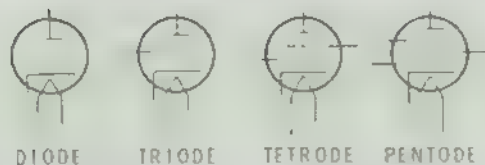
The symbols of the four basic types of tubes are shown in Figure 6-11. Note that the name of each type corresponds to the number of elements within the tube. The heater may or may not be shown on the symbol of a tube.



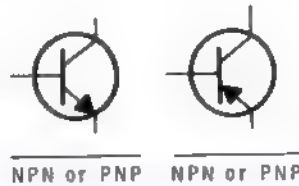
**Figure 6-11**

It is not necessary for you to remember the names given the elements within a tube at this time. You should, however, be able to name each type of tube when you are given its symbol.

Draw the symbols of the four main types of tubes and label them.

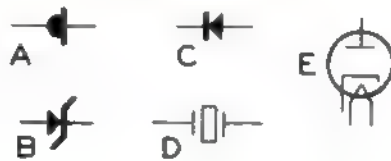


26. Label the following transistor symbols by type (NPN or PNP).



NPN      PNP

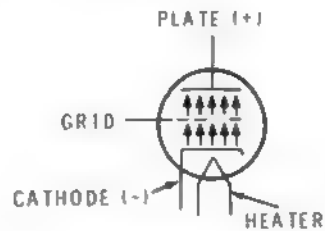
27. Which of the following is the symbol of a tunnel diode?



A



28. One of the main purposes of a tube is to amplify (make larger) a voltage or signal. A tube accomplishes this by controlling the amount of current flow through the tube. Normally, a tube is connected as shown in Figure 6-12. Note that the plate is positive (+) with respect to the cathode (-).



**Figure 6-12**

The operation of a vacuum tube is quite simple. The heater heats the cathode and causes electrons to be boiled off. These electrons are then attracted to the highly positive plate of the tube. The grid, in this case called a "control" grid, affects the amount of electron (current) flow much the same as a faucet controls the water flow from a pipe. A small change in control grid voltage causes a **large** change in plate voltage.

**The main thing to remember is that the current flows from the cathode to the plate of a tube.**

Current flows from the \_\_\_\_\_ to the \_\_\_\_\_ of the tube.

Control Grid Plate

29. Write the letters, beside the tube symbols in the left column, in the corresponding blanks in the right column.



Diode \_\_\_\_\_

Triode \_\_\_\_\_

Tetrode \_\_\_\_\_

Pentode \_\_\_\_\_

B  
A  
D  
C

30. Which of the following symbols is **not** labeled correctly?



E

31. A voltmeter is used to measure electromotive force (EMF) or a difference of potential. Figure 6-13 shows the symbol of a voltmeter.



**Figure 6-13**

Draw the symbol of a voltmeter.

+ V -

32. Which of the following statements is true concerning current flow in a vacuum tube?

- A. Current flows from plate to cathode.
- B. Current flows from grid to plate.
- C. Current flows from cathode to plate.
- D. Current flows from cathode to grid.
- E. Current flows from plate to grid.

C

33. How many elements do each of the following tubes have?

Triode \_\_\_\_\_  
 Pentode \_\_\_\_\_  
 Diode \_\_\_\_\_  
 Tetrode \_\_\_\_\_

3  
 5  
 2  
 4

34. An ammeter is used to measure current. Figure 6-14 shows the symbol of an ammeter.

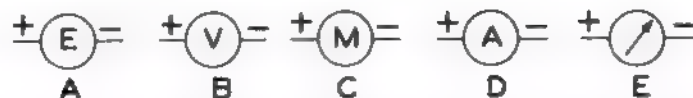


**Figure 6-14**

Draw the symbol of an ammeter.



35. Select the symbol of a voltmeter.



B

36. Which of the following statements is true concerning the current flow in a vacuum tube?

- A. Current flows from grid to plate.
- B. Current flows from cathode to grid.
- C. Current flows from plate to cathode.
- D. Current flows from cathode to plate.
- E. Current flows from plate to grid.

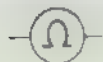
D

37. An ohmmeter is used to measure resistance. Figure 6-15 shows the symbol of an ohmmeter.

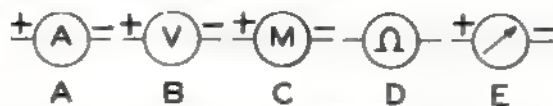


**Figure 6-15**

Draw the symbol of an ohmmeter.



38. Select the symbol of an ammeter.



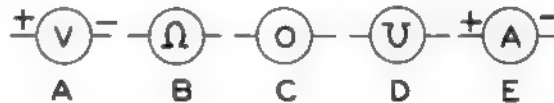
A

39. What kind of meter is shown below?

- A. A voltmeter.
- B. An ammeter.
- C. A current meter.
- D. An ohmmeter.
- E. A volume meter.



40. Select the symbol of an ohmmeter.



41. What kind of meter is shown below?

- A. An amplitude meter.
- B. A voltmeter.
- C. An ammeter.
- D. An ohmmeter.
- E. An acoustic meter.



42. What kind of meter is shown below?

- A. A curve meter.
- B. An ohmmeter.
- C. A mhometer.
- D. A voltmeter.
- E. An all-purpose meter.



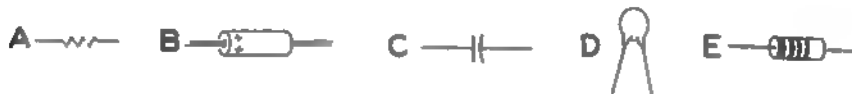
Proceed to the audio "Review of Circuit Components" (Tape 1, Side B).

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than three questions, go back and re-read this whole module.
- If you have less than three incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer refers you to the proper frame). Then proceed to the next module.

1. Select the symbol of a resistor.



2. Which of the following is the symbol of a capacitor?



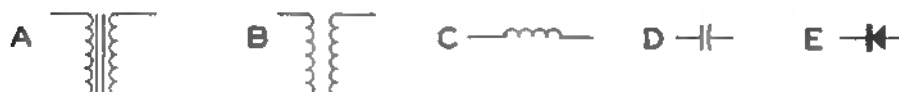
3. Select the symbol of a crystal.



4. Which of the following is the symbol of an iron core inductor?



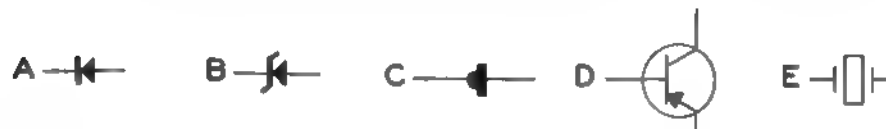
5. Select the symbol of an iron core transformer.



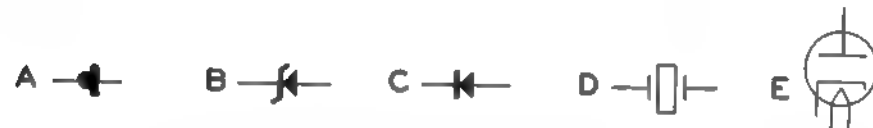
6. Which of the following is the symbol of an ordinary diode?



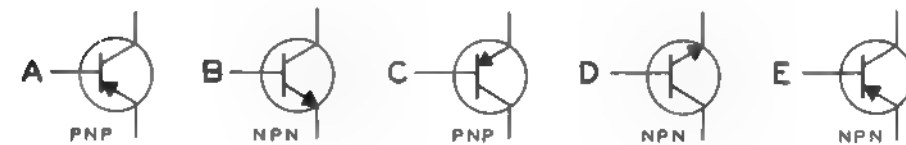
7. Select the symbol of a zener diode.



8. Which of the following is the symbol of a tunnel diode?



9. Select the symbol that is **not** labeled correctly.



10. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode
- D. Tetrode.
- E. Heptode.



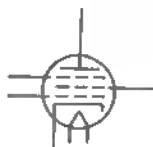
11. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Heptode.



12. What type of tube is shown below?

- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Pentagrid.



13. What type of tube is shown below?

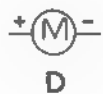
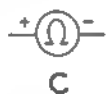
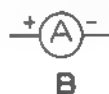
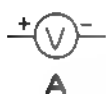
- A. Pentode.
- B. Triode.
- C. Diode.
- D. Tetrode.
- E. Heptode.



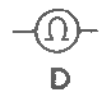
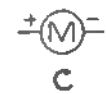
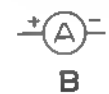
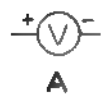
14. Select the true statement concerning the current flow in a vacuum tube.

- A. Current flows from grid to plate.
- B. Current flows from grid to cathode.
- C. Current flows from plate to cathode.
- D. Current flows from cathode to plate.
- E. Current flows from plate to grid.

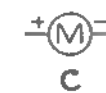
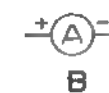
15. Select the symbol of a voltmeter.



16. Select the symbol of an ammeter.



17. Select the symbol of an ohmmeter.





**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	A	(1)
2.	B	(2)
3.	D	(4)
4.	B	(7)
5.	A	(10)
6.	C	(13)
7.	B	(16)
8.	A	(19)
9.	E	(22)
10.	D	(25)
11.	B	(25)
12.	A	(25)
13.	C	(25)
14.	D	(28)
15.	A	(31)
16.	B	(34)
17.	D	(37)



# Individual Learning Program

In

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PRACTICAL  
CIRCUITS





# Individual Learning Program

## AMATEUR RADIO

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*Module 7*

### PRACTICAL CIRCUITS

ER-3701

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## MODULE OBJECTIVES

When you complete this module, you will be able to select or identify:

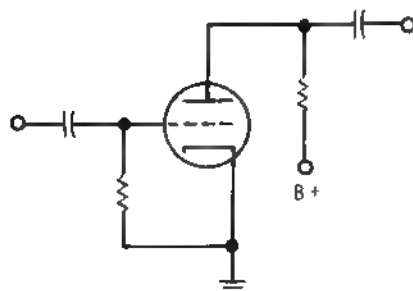
1. The schematic (diagram) of a basic amplifier circuit and recognize errors in the schematic.
2. The schematic of a basic oscillator circuit and recognize errors in the schematic.
3. The correct name and sequence of each main circuit in a simple transmitter.
4. The correct name and sequence of each main circuit in a simple receiver.
5. The purpose of a key-click filter and how to connect it.
6. The purpose of a low-pass filter.
7. The purpose of a high-pass filter.
8. The schematic of a half-wave rectifier circuit.
9. The schematic of a full-wave rectifier circuit.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

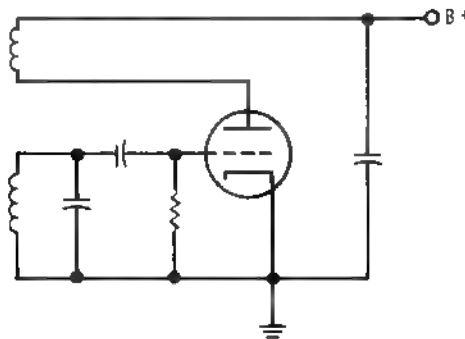
- If you miss more than two questions, read this whole module.
- If you have less than two incorrect answers, you may either study those frames pertaining to the questions you missed (the number in the parentheses, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the next module.

1. What kind of circuit is shown below?



- A. A low-pass filter.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A full-wave rectifier circuit.
- E. A half-wave rectifier.

2. What kind of circuit is shown below?



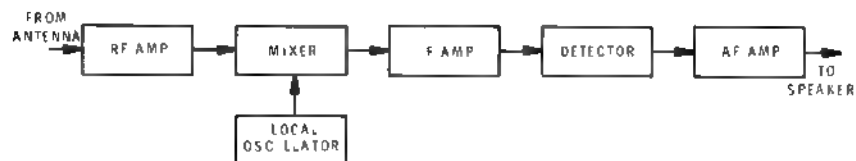
- A. A basic oscilloscope circuit.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A basic amplitude circuit.
- E. None of the above.

3. What does the following block diagram represent?



- A. A simple transmitter.
- B. A simple receiver.
- C. A key-click filter.
- D. A basic amplifier.
- E. A low-pass filter.

4. What does the following block diagram represent?

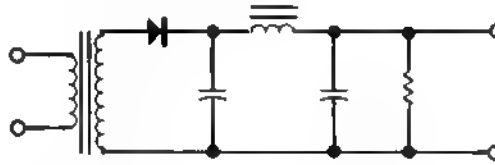


- A. A simple amplifier.
- B. A simple receiver.
- C. A simple transmitter.
- D. A high-pass filter.
- E. A simple oscillator.

5. Which of the following best describes the purpose of a key-click filter?
- A. A key-click filter is used on a receiver to remove spikes on received signals.
  - B. A key-click filter is used on a receiver to remove spikes on a transmitted signal.
  - C. A key-click filter is used on a transmitter to remove spikes on a received signal.
  - D. A key-click filter is used on a telegraph key to remove spikes caused when you suddenly open or close a telegraph key.
  - E. A key-click filter is used on the antenna to remove spikes caused when you open and close a telegraph key.
6. Which of the following statements is true concerning the purpose of a low-pass filter?
- A. The purpose of a low-pass filter is to pass signals below a certain frequency but block any higher frequency signals.
  - B. The purpose of a low-pass filter is to block signals below a certain frequency but pass any higher frequency signals.
  - C. The purpose of a low-pass filter is to pass signals above a certain frequency but block any lower frequency signals.
  - D. All of the above are true.
  - E. None of the above are true.
7. Which of the following statements is true concerning the purpose of a high-pass filter?
- A. The purpose of a high-pass filter is to pass signals below a certain frequency but block higher frequency signals.
  - B. The purpose of a high-pass filter is to block signals above a certain frequency but pass lower frequency signals.
  - C. The purpose of a high-pass filter is to pass signals above a certain frequency but block signals below this frequency.
  - D. All of the above are true.
  - E. None of the above are true.

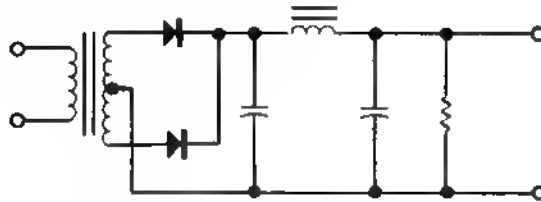


8. What kind of circuit is shown below?



- A. A half-wave receiver circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A basic receiver circuit.
- E. A half-wave rectifier circuit.

9. What kind of circuit is shown below?



- A. A half-wave rectifier circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A full-wave receiver circuit.
- E. An oscillator circuit.

**PRETEST ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	B	(1)
2.	C	(2)
3.	A	(4)
4.	B	(7)
5.	D	(10)
6.	A	(13)
7.	C	(16)
8.	E	(19)
9.	B	(22)

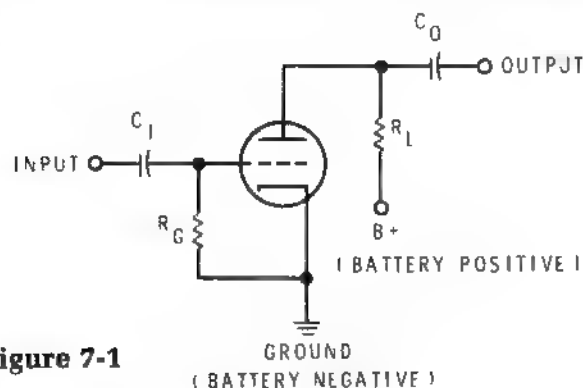
## INTRODUCTION

In Module Six, you learned some of the basic symbols for several electronic components. This module will use these basic symbols to teach you the schematic diagrams of some of the basic electronic circuits. You will also learn the purpose of three different types of filters.

## PROGRAMMED INSTRUCTION

1. One of the most common circuits used in electronic equipment is called an amplifier circuit. An amplifier circuit, as its name implies, amplifies (or enlarges) a signal.

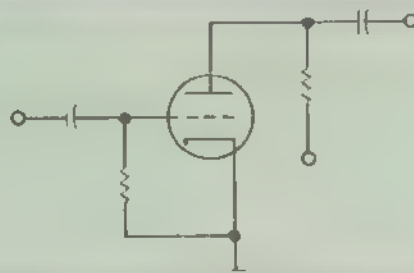
Figure 7-1 shows the schematic of a basic tube amplifier circuit.



**Figure 7-1**

Capacitors  $C_1$  and  $C_0$  are called input and output coupling capacitors. These capacitors allow the AC signal to pass from the previous circuit to the amplifier circuit, but yet block the DC. Resistors  $R_G$  and  $R_L$  set the operating voltages on the tube for normal operation.

Draw the schematic of a basic tube amplifier circuit. It is not necessary to label the components.



2. An oscillator circuit is another common circuit used in electronic equipment. Oscillator circuits are used to generate an AC signal.

Figure 7-2 shows the schematic of a basic tube oscillator circuit.

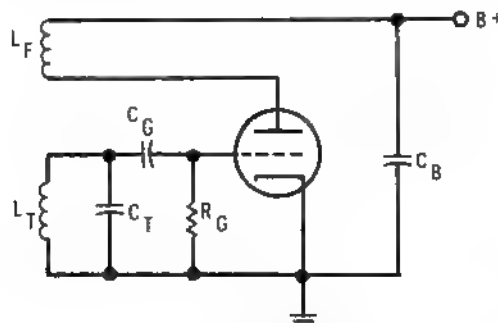
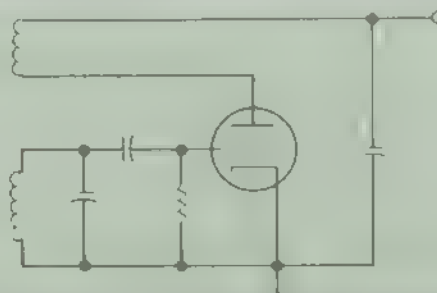


Figure 7-2

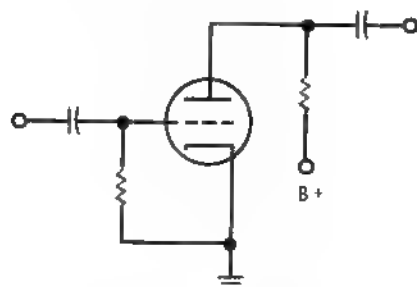
The most noticeable difference between an oscillator circuit and an amplifier circuit is the addition of a tuned circuit and some type of feedback.

Coil  $L_T$  and capacitor  $C_T$  form a tuned circuit, called a tank circuit, that will oscillate at a specific frequency. Coil  $L_F$ , the feedback loop, feeds back some of the oscillations from the plate of the tube to the tank circuit. This action keeps the oscillator running. Capacitor  $C_B$ , is a bypass capacitor which prevents the oscillations from entering the power supply (battery) circuit.

Draw the schematic of a basic tube oscillator circuit. It is not necessary to label the components.



3. What kind of circuit is shown below?



- A. A basic oscilloscope circuit.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A basic amplitude circuit.
- E. None of the above.

B

4. A basic novice transmitter contains an oscillator, one or more frequency multiplier stages, and a final amplifier (power amplifier) which contains tuning and loading controls.

Figure 7-3 shows the "block" diagram of a basic novice transmitter.



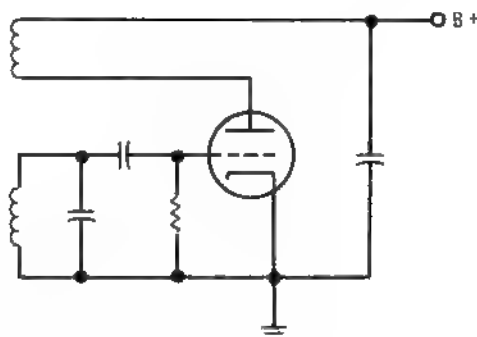
**Figure 7-3**

The oscillator generates the radio frequency, the frequency multiplier stage increases the oscillator frequency to the proper operating frequency, and the final amplifier boosts this signal and drives the antenna.

Draw the block diagram of a basic novice transmitter and label the blocks.



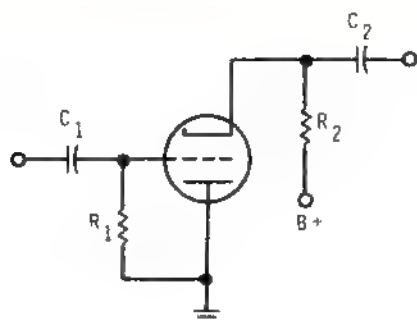
5. What kind of circuit is shown below?



- A. A basic oscilloscope circuit.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A basic amplitude circuit.
- E. None of the above.

C

6. What is wrong with the amplifier circuit shown below?



- A. B+ is indicated at the wrong location.
- B. Resistor  $R_1$  is connected to wrong points.
- C. Resistor  $R_2$  is connected to wrong point.
- D. Nothing is wrong.
- E. The tube is drawn upside down.

E



7. A basic receiver contains an RF amplifier, a mixer, a local oscillator, an intermediate frequency (IF) amplifier, a detector, and an audio frequency (AF) amplifier.

Figure 7-4 shows the block diagram of a basic receiver.

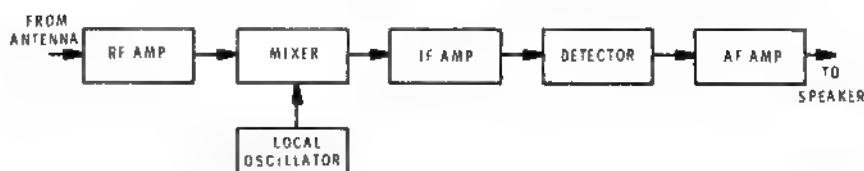


Figure 7-4

The purpose of the RF amplifier is to boost all of the incoming signals at the antenna. The local oscillator provides another signal (tunable) that is slightly different than the signals at the antenna. The mixer combines these two signals and provides a common signal frequency for use in the IF amplifier, which simply boosts the signal. The detector simply changes the IF signal to an audio (audible) signal which is amplified by the AF amplifier. The AF amplifier boosts the audio signal so that it sufficiently drives the speaker.

Draw the block diagram of a basic receiver and label the blocks.



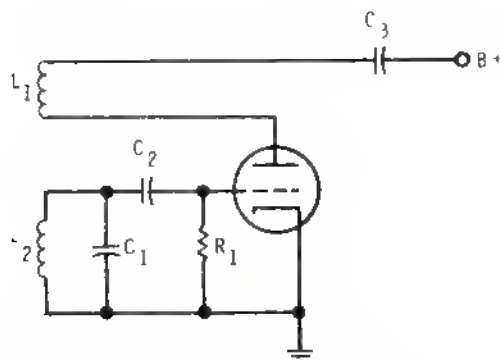
8. Write the numbers, beside the names in the right column, in the proper blocks of the transmitter block diagram shown below.



1. Final amplifier.
2. Oscillator.
3. Frequency multiplier.



9. What is wrong with the oscillator circuit shown below?



- A. Capacitor  $C_3$  is connected wrong.
- B. Capacitor  $C_2$  is connected wrong.
- C. Coil  $L_2$  is connected wrong.
- D. Resistor  $R_1$  is connected wrong.
- E. The tube is drawn upside down.

10. The purpose of a key-click filter is to remove the spikes caused when you suddenly open or close a telegraph key.

Figure 7-5 shows a method of connecting a simple key-click filter across a telegraph key. The values given for the resistor and capacitor are typical values. This type of filter should be as close to the key as practical.

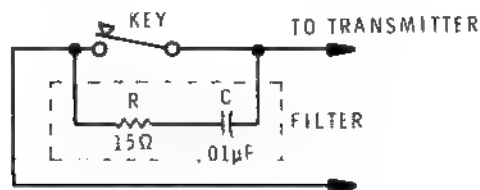


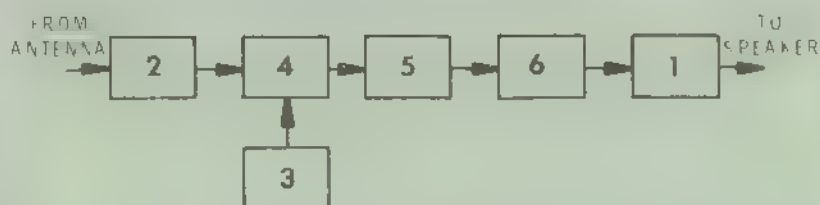
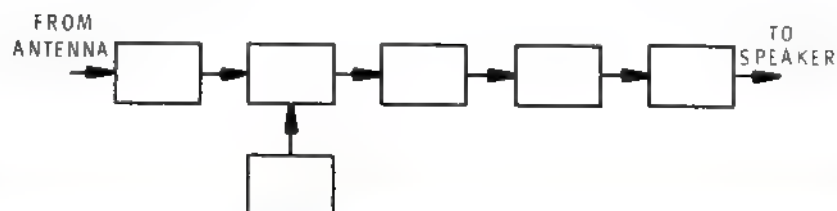
Figure 7-5

The purpose of a key-click filter is to \_\_\_\_\_ the spikes caused when you suddenly open or close a \_\_\_\_\_.

remove      telegraph key

11. Write the numbers, beside the names given below, in the proper blocks of the receiver diagram.

- |                      |                 |
|----------------------|-----------------|
| 1. AF Amplifier.     | 4. Mixer.       |
| 2. RF Amplifier.     | 5. IF Amplifier |
| 3. Local Oscillator. | 6. Detector.    |



12. What is the name of block #3 in the following transmitter block diagram?



- A. Oscillator.
- B. Frequency multiplier.
- C. Detector.
- D. AF amplifier.
- E. Final amplifier.

E

13. The purpose of a low-pass filter is to pass signals below a particular frequency but block any higher frequency signals.

The particular frequency mentioned above, called the cutoff frequency, is determined by the filter's design.

Low-pass filters are used at the output of a transmitter to suppress interference with other higher frequency receivers. One specific use of the filter is to prevent interference to television receivers.

The purpose of a low-pass filter is to \_\_\_\_\_ signals below a particular frequency but \_\_\_\_\_ any higher frequency signals.

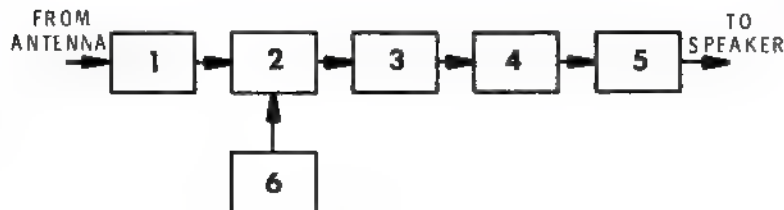
pass      block

14. Which of the following best describes the purpose of a key-click filter?

- A. A key-click filter is used on a receiver to remove spikes on received signals.
- B. A key-click filter is used on a receiver to remove spikes on a transmitted signal.
- C. A key-click filter is used on a transmitter to remove spikes on a received signal.
- D. A key-click filter is used on a telegraph key to remove the spikes caused when you suddenly open or close the key.
- E. A key-click filter is used on the antenna to remove spikes caused when you open and close a telegraph key.

D

15. What is the name of block #4 in the following receiver block diagram?



- A. Local oscillator.
- B. AF amplifier.
- C. RF amplifier.
- D. IF amplifier.
- E. Detector.

E

- 16. The purpose of a high-pass filter is to pass signals above a certain frequency but block signals below this frequency.**

High-pass filters are used at the antenna input terminals of a receiver to reduce interference from a nearby transmitter. A common use of this type of filter is at the antenna terminals on a television set.

The purpose of a high-pass filter is to \_\_\_\_\_ signals above a certain frequency but \_\_\_\_\_ signals below this frequency.

pass      block

- 17. Which of the following statements is true concerning the purpose of a low-pass filter?**

- A. The purpose of a low-pass filter is to pass signals below a particular frequency but block any higher frequency signals.
- B. The purpose of a low-pass filter is to block signals below a particular frequency but pass any higher frequency signals.
- C. The purpose of a low-pass filter is to pass signals above a particular frequency but block any lower frequency signals.
- D. All of the above are true.
- E. None of the above are true.

A

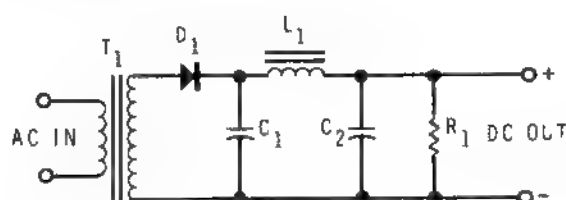
- 18. Where should you connect a key-click filter?**

- A. Across the antenna terminals at your antenna.
- B. Across the antenna terminals at your receiver.
- C. Across the antenna terminals at your transmitter.
- D. Across the contacts of your telegraph key.
- E. Across your speaker terminals.

D

19. As you should recall from an earlier module, rectification is the process of changing AC into DC.

The circuit shown in Figure 7-6 is called a half-wave rectifier. This circuit gets its name from the fact that current flows for only half of the time.

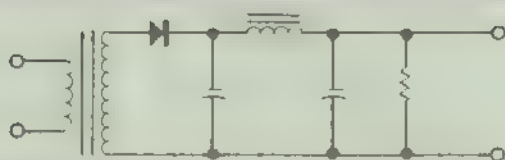


**Figure 7-6**

In this circuit, transformer  $T_1$  steps the AC input voltage either up or down as required. Diode  $D_1$  changes the AC into pulsating DC and capacitors  $C_1$ ,  $C_2$ , and choke  $L_1$  smooth out these pulsations. Resistor  $R_1$ , also called a bleeder resistor, discharges the capacitor when the AC input voltage is removed. This resistor also improves the voltage regulation (helps hold the output voltage constant).

**NOTE:** The type of filter shown in Figure 7-6 is called a capacitor-input filter, since the first component after the diode is a capacitor. If  $C_1$  was removed from this circuit the filter would be called a choke-input filter.

Draw the schematic of a half-wave rectifier with a capacitor-input filter. It is not necessary to label the components.





**20.** Which of the following statements is true concerning the purpose of a high-pass filter?

- A. The purpose of a high-pass filter is to pass signals below a certain frequency but block higher frequency signals.
- B. The purpose of a high-pass filter is to block signals above a certain frequency but pass lower frequency signals.
- C. The purpose of a high-pass filter is to pass signals above a certain frequency but block signals below this frequency.
- D. All of the above are true.
- E. None of the above are true.

C

**21.** What type of filter would pass signals below a certain frequency but block any higher frequency signals?

- A. A key-click filter.
- B. A low-pass filter.
- C. A low block filter.
- D. A high-pass filter.
- E. A bandpass filter.

B

22. Another circuit commonly used to change AC into DC is called a full-wave rectifier.

Figure 7-7 shows the schematic of a full-wave rectifier circuit. This circuit gets its name from the fact that current flows all the time.

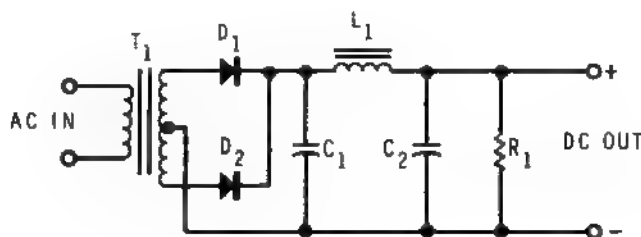
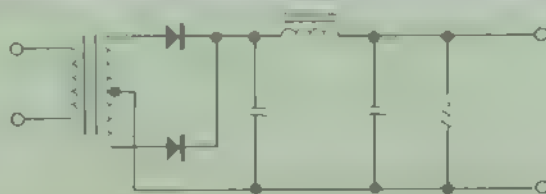


Figure 7-7

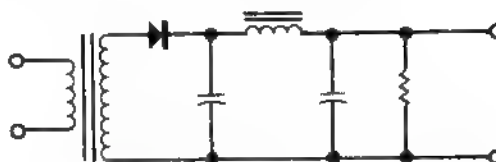
In this circuit, transformer  $T_1$  (which must have a center-tapped winding) steps the AC input voltage up or down as required and diodes  $D_1$  and  $D_2$  change this voltage to pulsating DC. The rest of the circuit operates in the same manner as it does in the half-wave rectifier circuit.

Again, the type of filter shown in Figure 7-7 is a capacitor-input type, since the first component following the diodes is a capacitor.

Draw the schematic of a full-wave rectifier circuit with a capacitor-input filter. It is not necessary to label the components.



23. What kind of circuit is shown below?



- A. A half-wave regulator circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A full-wave regulator circuit.
- E. A half-wave rectifier circuit.

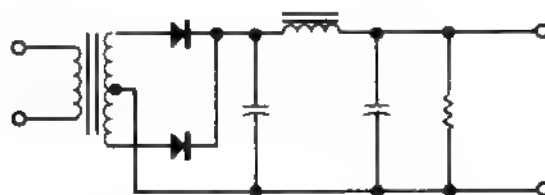
E

24. What type of filter would pass signals above a certain frequency but block any lower frequency signals?

- A. A low-pass filter.
- B. A high-pass filter.
- C. A high block filter.
- D. A key-click filter.
- E. A bandpass filter.

B

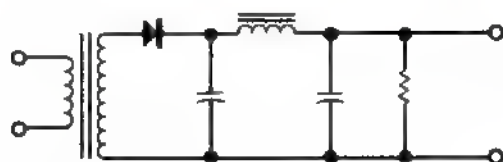
25. What kind of circuit is shown below?



- A. A full-wave rectifier circuit.
- B. A key-click filter.
- C. A half-wave regulator circuit.
- D. A full-wave regulator circuit.
- E. A half-wave rectifier circuit.

A

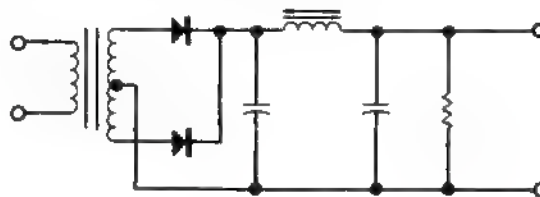
26. What kind of circuit is shown below?



- A. A half-wave regulator circuit.
- B. A bandpass filter.
- C. A half-wave rectifier circuit.
- D. A full-wave rectifier circuit.
- E. A key-click filter.

C

27. What kind of circuit is shown below?



- A. A half-wave rectifier circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A full-wave regulator circuit.
- E. An oscillator circuit.

B

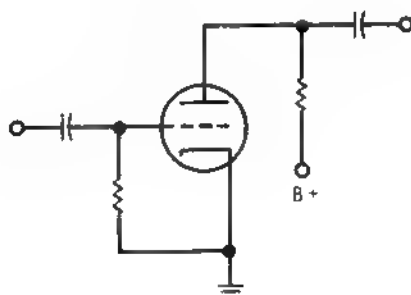
Proceed to the audio "Review of Practical Circuits" (Tape 1, Side B).

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

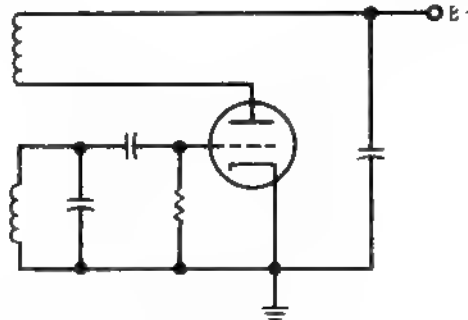
- If you miss more than two questions, re-read this whole module.
- If you have less than two incorrect answers, go back and study those frames pertaining to the questions you missed (the number in the parentheses, following the correct answer, refers you to the proper frame). Then proceed to the next module.

1. What kind of circuit is shown below?



- A. A low-pass filter.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A full-wave rectifier circuit.
- E. A half-wave rectifier.

2. What kind of circuit is shown below?



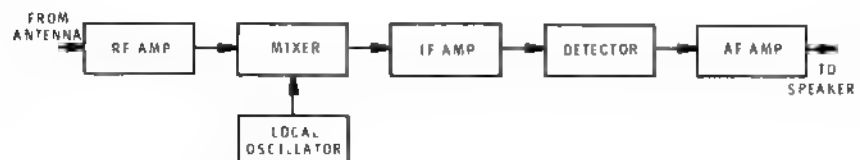
- A. A basic oscilloscope circuit.
- B. A basic amplifier circuit.
- C. A basic oscillator circuit.
- D. A basic amplitude circuit.
- E. None of the above.

3. What does the following block diagram represent?



- A. A simple transmitter.
- B. A simple receiver.
- C. A key-click filter.
- D. A basic amplifier.
- E. A low-pass filter.

4. What does the following block diagram represent?

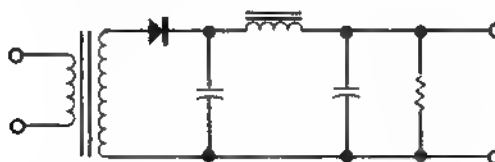


- A. A simple amplifier.
- B. A simple receiver.
- C. A simple transmitter.
- D. A high-pass filter.
- E. A simple oscillator.

5. Which of the following best describes the purpose of a key-click filter?
- A. A key-click filter is used on a receiver to remove spikes on received signals.
  - B. A key-click filter is used on a receiver to remove spikes on a transmitted signal.
  - C. A key-click filter is used on a transmitter to remove spikes on a received signal.
  - D. A key-click filter is used on a telegraph key to remove spikes caused when you suddenly open or close a telegraph key.
  - E. A key-click filter is used on the antenna to remove spikes caused when you open and close a telegraph key.
6. Which of the following statements is true concerning the purpose of a low-pass filter?
- A. The purpose of a low-pass filter is to pass signals below a certain frequency but block any higher frequency signals.
  - B. The purpose of a low-pass filter is to block signals below a certain frequency but pass any higher frequency signals.
  - C. The purpose of a low-pass filter is to pass signals above a certain frequency but block any lower frequency signals.
  - D. All of the above are true.
  - E. None of the above are true.
7. Which of the following statements is true concerning the purpose of a high-pass filter?
- A. The purpose of a high-pass filter is to pass signals below a certain frequency but block higher frequency signals.
  - B. The purpose of a high-pass filter is to block signals above a certain frequency but pass lower frequency signals.
  - C. The purpose of a high-pass filter is to pass signals above a certain frequency but block signals below this frequency.
  - D. All of the above are true.
  - E. None of the above are true.

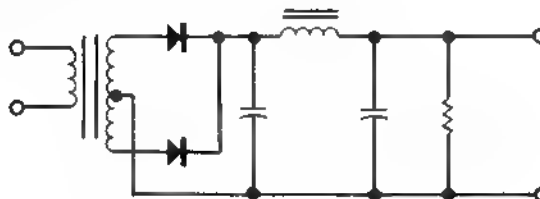


8. What kind of circuit is shown below?



- A. A half-wave receiver circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A basic receiver circuit.
- E. A half-wave rectifier circuit.

9. What kind of circuit is shown below?



- A. A half-wave rectifier circuit.
- B. A full-wave rectifier circuit.
- C. A key-click filter.
- D. A full-wave receiver circuit.
- E. An oscillator circuit.



**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	B	(1)
2.	C	(2)
3.	A	(4)
4.	B	(7)
5.	D	(10)
6.	A	(13)
7.	C	(16)
8.	E	(19)
9.	B	(22)



# Individual Learning Program In

**AMATEUR RADIO**  
(NOVICE LICENSE)

8  
ANTENNAS AND  
TRANSMISSION  
LINES





# **Individual Learning Program**

## **AMATEUR RADIO** (NOVICE LICENSE)

### *Module 8* **ANTENNAS AND TRANSMISSION LINES** ER-3701

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BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When you complete this module, you will be able to select or determine:

1. The meaning of "electrical length."
2. The meaning of "antenna input impedance."
3. The meaning of "characteristic impedance."
4. The meaning of "dipole antenna."
5. The meaning of "standing waves."
6. The meaning of "transmatch."
7. The formula for determining the length in feet of a half-wave antenna.
8. The approximate length of a half-wave antenna suitable for use on the 80-meter novice band.
9. The approximate length of a half-wave antenna suitable for use on the 40-meter novice band.
10. The approximate length of a half-wave antenna suitable for use on the 15-meter novice band.
11. The approximate length of a half-wave antenna suitable for use on the 10-meter novice band.
12. The meaning of "harmonic operation."
13. The three main types of transmission line.
14. The meaning of "standing wave ratio."
15. The most used method of determining SWR.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than three questions, read this whole module.
  - If you have less than three incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the next module.
1. The **electrical** length of an antenna refers to which of the following?
    - A. Its physical length.
    - B. Its length in feet.
    - C. Its length in yards.
    - D. Its length in wavelengths.
    - E. Its length in inches.
  2. Select the true statement concerning antenna input impedance.
    - A. Antenna input impedance is the same at all points along an antenna.
    - B. Antenna input impedance is the same as characteristic impedance.
    - C. Antenna input impedance depends on the impedance of the feedline.
    - D. Antenna input impedance is the impedance of an antenna at the point where the feedline is attached.
    - E. None of the above.
  3. What does characteristic impedance refer to?
    - A. The average impedance of a dipole antenna.
    - B. The impedance at the center of an antenna.
    - C. The average impedance of any antenna.
    - D. The impedance of an antenna and its feedline.
    - E. The impedance of a transmission line.



4. Which of the following best describes a dipole antenna?
- A. A dipole antenna is an antenna which has the signal applied at one end and is usually one-half wave long.
  - B. A dipole antenna is an antenna which has the signal applied at both ends and is usually one-half wave long.
  - C. A dipole antenna is an antenna which has the signal applied at its center and is usually one-half wave long.
  - D. A dipole antenna is an antenna which has the signal applied at its center and is usually one full wave long.
  - E. A dipole antenna is an antenna which usually has the signal applied at its center and is two waves long.
5. Select the best definition of a standing wave.
- A. A standing wave is a motionless wave on an antenna that is caused by a perfect match.
  - B. A standing wave is a motionless wave on an antenna that is caused by a mismatch.
  - C. A standing wave is a moving wave on an antenna that is caused by a perfect match.
  - D. A standing wave is a motionless wave on an antenna that causes a perfect match.
  - E. A standing wave is a motionless wave on an antenna that causes a mismatch.
6. Select the best description of a transmatch.
- A. A transmatch is an adjustable matching device.
  - B. A transmatch matches the output impedance of a transmitter to that of a transmission line.
  - C. A transmatch improves the efficiency of an antenna system.
  - D. A transmatch attenuates harmonics.
  - E. All of the above.
7. Select the correct equation for determining the length of a half-wave antenna.

A.  $L_{(ft)} = \frac{468}{F \text{ (kHz)}}$

$$B. \quad L_{(m)} = \frac{468}{F \text{ (MHz)}}$$

$$C. \quad L_{(m)} = \frac{468}{F \text{ (Hz)}}$$

$$D. \quad L_{(m)} = \frac{468}{F \text{ (MHz)}}$$

$$E. \quad F = \frac{468}{L}$$

8. Select the approximate length of a half-wave antenna suitable for use on the 80-meter novice band.

A. 126 feet.  
 B. 66 feet.  
 C. 80 feet.  
 D. 40 feet.  
 E. 63 feet.

9. Select the approximate length of a half-wave antenna suitable for use on the 40-meter novice band.

A. 126 feet.  
 B. 40 feet.  
 C. 66 feet.  
 D. 20 feet.  
 E. 33 feet.

10. Select the approximate length of a half-wave antenna suitable for use on the 15-meter novice band.

A. 15 feet.  
 B. 126 feet.  
 C. 22 feet.  
 D. 66 feet.  
 E. 11 feet.

11. Select the approximate length of a half-wave antenna suitable for use on the 10-meter novice band.
- A. 126 feet.
  - B. 66 feet.
  - C. 5 feet.
  - D. 11 feet.
  - E. 17 feet.
12. Which of the following statements best describes harmonic operation?
- A. Harmonic operation is the practice of using a dipole antenna at an even multiple of its normal operating frequency.
  - B. Harmonic operation is the practice of using a dipole antenna at an odd multiple of its normal operating frequency.
  - C. Harmonic operation is the practice of using a dipole antenna at a frequency that is less than its normal operating frequency.
  - D. Harmonic operation is the practice of using a dipole antenna at any frequency other than its normal operating frequency.
  - E. Harmonic operation is the practice of using a dipole antenna at any frequency that is higher than its normal operating frequency.
13. Which of the following is **not** a commonly used type of transmission line?
- A. Zip cord.
  - B. Coaxial cable.
  - C. Ribbon wire.
  - D. Single wire.
  - E. Open-wire parallel line.

14. Which of the following best describes standing wave ratio?
- A. Standing wave ratio is a comparison of maximum voltage to minimum current along a line.
  - B. Standing wave ratio is a comparison of maximum current to minimum voltage along a line.
  - C. Standing wave ratio is the difference between the maximum voltage (or current) and the minimum voltage (or current) along a line.
  - D. Standing wave ratio is a comparison of maximum voltage (or current) to the minimum voltage (or current) along a line.
  - E. None of the above.
15. Which of the following is the most common method of measuring SWR?
- A. With a voltmeter.
  - B. With an SWR bridge.
  - C. With an ammeter.
  - D. With a VTVM.
  - E. With an ohmmeter.

## PRETEST ANSWERS

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	D	(2)
3.	E	(4)
4.	C	(7)
5.	B	(10)
6.	E	(13)
7.	D	(16)
8.	A	(19)
9.	C	(22)
10.	C	(25)
11.	E	(28)
12.	B	(31)
13.	A	(34)
14.	D	(37)
15.	B	(40)

## INTRODUCTION

Many amateur radio operators consider the antenna system to be the most important part of their stations.

This module deals with antennas and the proper methods of coupling the signal from the transmitter to the antenna. You will learn the importance of matching the transmitter to the feedline and the feedline to the antenna. You will also learn how to determine the length of an antenna for a specific frequency and the approximate lengths for each novice band.

## PROGRAMMED INSTRUCTION

1. You should recall from Module 2 that wavelength is the length of one cycle of a radio wave.

Antennas are usually made to operate at a specific number of wavelengths (half, quarter, etc.) at the operating frequency. This practice results in the best antenna efficiency.

**The electrical length of an antenna refers to its length in wavelengths.**

The electrical length of an antenna is always greater than its physical length, since a radio wave has less velocity at a given antenna installation than it does in free space.

The electrical length of an antenna refers to its \_\_\_\_\_ in \_\_\_\_\_.

length      wavelengths

2. Circuits that contain capacitance or inductance and operate at some frequency have what is called impedance instead of resistance. Impedance, like resistance, also uses ohms as its unit of measure. Impedance cannot, however, be measured with an ordinary ohmmeter.

**The impedance of an antenna at the point where the lead-in (called a feedline or transmission line) is attached is called the antenna input impedance.**

Note that the impedance is not the same at all points along a given antenna.

The impedance of an antenna at the point where the feedline is attached is called the \_\_\_\_\_.

antenna input impedance

3. The electrical length of an antenna refers to which of the following?

- A. Its physical length.
- B. Its length in wavelengths.
- C. Its length in feet.
- D. Its length in yards.
- E. Its length in inches.

B

4. The impedance of a transmission line, or feedline, is expressed as its "characteristic impedance."

The characteristic impedance of a line depends on the size (diameter) of the line's conductors, or wires, and the space between the conductors.

The impedance of a transmission line is expressed as its \_\_\_\_\_.

characteristic impedance

5. Which of the following statements concerning antenna input impedance is true?

- A. The antenna input impedance is the impedance of an antenna at the point where the feedline is attached.
- B. Antenna input impedance is the same at all points along an antenna.
- C. Antenna input impedance is the same as characteristic impedance.
- D. Antenna input impedance depends on the impedance of the feedline.
- E. All of the above.

A

6. The electrical length of an antenna refers to which of the following?

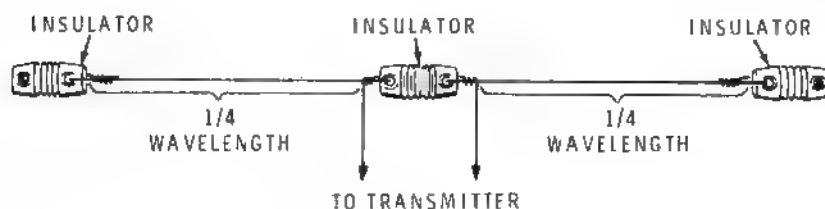
- A. Its physical length.
- B. Its length in feet.
- C. Its length in yards.
- D. Its length in wavelengths.
- E. Its length in inches.

D

7. One of the most used antenna types for beginners is the "dipole antenna."

**A dipole antenna is an antenna which usually has the signal applied at its center. Dipole antennas are usually one-half wave in length.**

Figure 8-1 shows a typical half-wave dipole antenna. Note that each side of the antenna is  $1/4$  wavelength, which results in a total length of  $1/2$  wavelength.



**Figure 8-1**

A dipole antenna is an antenna which usually has the signal applied at its \_\_\_\_\_. Dipole antennas are usually one-\_\_\_\_\_ wave in length.

center    half



8. Which of the following best describes characteristic impedance.

- A. The impedance at the center of an antenna.
- B. The impedance of a transmission line.
- C. The average impedance of any antenna.
- D. The average impedance of a dipole antenna.
- E. The impedance of an antenna and its feedline.

B

9. Select the true statement concerning antenna input impedance.

- A. Antenna input impedance is the same at all points along the antenna.
- B. Antenna input impedance is the same as characteristic impedance.
- C. Antenna input impedance depends on the impedance of the feedline.
- D. Antenna input impedance is the impedance of an antenna at the point where the feedline is attached.
- E. None of the above.

D

10. For maximum efficiency, an antenna must be the proper length for the frequency at which it operates. Just as important, the characteristic impedance of the transmission line and the antenna input impedance must match. If a mismatch occurs anywhere in the antenna system, standing waves will result.

**A standing wave is a motionless wave on an antenna that is caused by a mismatch.**

When an impedance mismatch occurs in an antenna system, voltage and current is reflected back down the transmission line toward the transmitter. This causes a power loss and results in poor antenna efficiency.

A standing wave is a \_\_\_\_\_ wave on an antenna that is caused by a \_\_\_\_\_.

motionless      mismatch

11. Which of the following statements is true?

- A. A dipole antenna is an antenna which has the signal applied at either end and is usually one-half wave long.
- B. A dipole antenna is an antenna which has the signal applied at either end and is usually one full wave long.
- C. A dipole antenna is an antenna which has the signal applied at its center and is usually one-half wave long.
- D. A dipole antenna is an antenna which has the signal applied at its center and is usually one full wavelength.
- E. A dipole antenna is an antenna which usually has the signal applied at its center and is usually one-quarter wave long.

C.

12. What does characteristic impedance refer to?

- A. The average impedance of a dipole antenna.
- B. The impedance at the center of an antenna.
- C. The average impedance of any antenna.
- D. The impedance of an antenna and its feedline.
- E. The impedance of a transmission line.

E

13. Just as important as the impedance of the feedline matching the antenna, the output impedance of the transmitter must also match the impedance of the feedline.

**An adjustable device that is able to match the output impedance of a transmitter to that of a feedline and, at the same time, attenuate harmonics (reduce unwanted frequencies) is called a transmatch.**

A transmatch improves the efficiency of an antenna system and reduces the possibility of interference to other communications.

An adjustable device that is able to match the output \_\_\_\_\_ of a transmitter to that of a feedline and, at the same time, \_\_\_\_\_ harmonics is called a transmatch.

impedance      attenuate

14. Which of the following best describes a standing wave?

- A. A standing wave is a motionless wave on an antenna that is caused by a mismatch.
- B. A standing wave is a moving wave on an antenna that is caused by a mismatch.
- C. A standing wave is a motionless wave on an antenna that is caused by a perfect match.
- D. A standing wave is a motionless wave on an antenna that causes a mismatch.
- E. A standing wave is a motionless wave on an antenna that causes a perfect match.

A

15. Which of the following best describes a dipole antenna?

- A. A dipole antenna is an antenna which has the signal applied at one end and is usually one-half wave long.
- B. A dipole antenna is an antenna which has the signal applied at both ends and is usually one-half wave long.
- C. A dipole antenna is an antenna which has the signal applied at its center and is usually one-half wave long.
- D. A dipole antenna is an antenna which has the signal applied at its center and is usually one full wave long.
- E. A dipole antenna is an antenna which usually has the signal applied at its center and is two waves long.

C

16. As you learned earlier, an antenna must be the proper length for the frequency at which it operates if you want maximum efficiency.

The equation for determining the length of a half-wave antenna is:

$$L_{(ft)} = \frac{468}{F \text{ (MHz)}}$$

Notice that the length (L) is in feet and the frequency (F) is in megahertz. If you are given the wavelength, such as "the 40 meter band," you must first change the wavelength in meters to the frequency in megahertz. The method of changing wavelength to frequency in megahertz was explained in Module 2.

What is the equation for determining the length of a half-wave antenna?

$$L_{(ft)} = \frac{468}{F \text{ (MHz)}}$$

17. Which of the following statements is true concerning a transmatch?

- A. A transmatch is an adjustable matching device.
- B. A transmatch matches the output impedance of a transmitter to that of a transmission line.
- C. A transmatch improves the efficiency of an antenna system.
- D. A transmatch attenuates harmonics.
- E. All of the above.

E

18. Select the best description of a standing wave.

- A. A standing wave is a motionless wave on an antenna that is caused by a perfect match.
- B. A standing wave is a motionless wave on an antenna that is caused by a mismatch.
- C. A standing wave is a moving wave on an antenna that is caused by a mismatch.
- D. A standing wave is a motionless wave on an antenna that causes a perfect match.
- E. A standing wave is a motionless wave on an antenna that causes a mismatch.

B

19. The approximate length of a half-wave antenna suitable for use on the 80-meter novice band (3.7 — 3.75 MHz) is 126 feet.

You can determine this by using the equation in frame 16:

$$L_{(ft)} = \frac{468}{3.725 \text{ MHz}}$$

$$L = 125.6 \text{ (round off to 126) feet.}$$

Antennas are usually cut for the center of the band of operation. In this case, 3.725 MHz is the center of the 80-meter novice band.

What is the approximate length of a half-wave antenna suitable for use on the 80-meter novice band? \_\_\_\_\_.

126 feet

20. Which of the following is the correct equation for determining the length of a half-wave antenna?

A.  $L_{(ft)} = \frac{468}{F \text{ (kHz)}}$

B.  $L_{(ft)} = \frac{300}{F \text{ (MHz)}}$

C.  $L_{(ft)} = \frac{468}{F \text{ (Hz)}}$

D.  $L_{(ft)} = \frac{468}{F \text{ (MHz)}}$

E.  $F = \frac{468}{L}$

D

21. Select the true statement concerning a transmatch.

- A. A transmatch is an adjustable matching device.
- B. A transmatch matches the output impedance of a transmitter to that of a transmission line.
- C. A transmatch improves the efficiency of an antenna system.
- D. A transmatch attenuates harmonics.
- E. All of the above.

E

22. The approximate length of a half wave antenna suitable for use on the 40-meter novice band (7.1 — 7.15 MHz) is 66 feet.

$$L_{(ft)} = \frac{468}{7.125 \text{ MHz}}$$

$$L = 65.6 \text{ (or 66) feet.}$$

What is the approximate length of a half-wave antenna suitable for use on the 40-meter novice band? \_\_\_\_\_.

66 feet

23. Which of the following is the approximate length of a half-wave antenna suitable for use on the 80-meter novice band?

- A. 126 feet.
- B. 66 feet.
- C. 80 feet.
- D. 40 feet.
- E. 63 feet.

A



24. Select the correct equation for determining the length of a half-wave antenna.

A.  $L_{(ft)} = \frac{468}{F \text{ (kHz)}}$

B.  $L_{(in)} = \frac{300}{F \text{ (MHz)}}$

C.  $L_{(ft)} = \frac{468}{F \text{ (Hz)}}$

D.  $L_{(ft)} = \frac{468}{F \text{ (MHz)}}$

E.  $F = \frac{468}{L}$

D

25. The approximate length of a half wave antenna suitable for use on the 15-meter novice band (21.1 — 21.2 MHz) is 22 feet.

$$L_{(ft)} = \frac{468}{21.15}$$

$$L = 22.1 \text{ (or 22) feet}$$

What is the approximate length of a half-wave antenna suitable for use on the 15-meter novice band? \_\_\_\_\_.

22 feet

26. Which of the following is the approximate length of a half-wave antenna suitable for use on the 40-meter novice band?

- A. 126 feet.
- B. 40 feet.
- C. 66 feet.
- D. 20 feet.
- E. 33 feet.

C

27. Which novice band would a half-wave antenna that is 126 feet long be used on?

- A. 40 meters.
- B. The 3.7 — 3.75 MHz band.
- C. 15 meters.
- D. 10 meters.
- E. The 7.1 — 7.15 MHz band.

B

28. The approximate length of a half-wave antenna suitable for use on the 10-meter novice band (28.1 — 28.2 MHz) is 17 feet.

$$L_{(ft)} = \frac{468}{28.15 \text{ MHz}}$$

$$L = 16.6 \text{ (or 17) feet}$$

What is the approximate length of a half-wave antenna suitable for use on the 10-meter novice band? \_\_\_\_\_.

17 feet

29. Which of the following is the approximate length of a half-wave antenna suitable for use on the 15-meter novice band?

- A. 15 feet.
- B. 126 feet.
- C. 22 feet.
- D. 66 feet.
- E. 11 feet.

C

30. Which novice band would a half-wave antenna that is 66 feet long be used on?

- A. The 7.1 — 7.15 MHz band.
- B. 80 meters.
- C. 15 meters.
- D. 10 meters.
- E. The 21.1 — 21.2 MHz band.

A

31. As you learned earlier, a dipole antenna works best at the frequency it was made for. A dipole antenna will also work satisfactorily at an odd multiple of its "cut for" frequency.

**When you use a dipole at an odd multiple of its normal operating frequency, you are using what is called "harmonic operation."**

Harmonic operation can be used to your advantage on the 40- and 15-meter bands. Since the frequency of the 15-meter band is three times the frequency of the 40-meter band, a 40-meter dipole will work well on 15 meters.

For maximum efficiency on both bands, the 40-meter dipole should be cut for the low end (around 7.1 MHz) of the band.

When you use a dipole at an odd multiple of its normal operating frequency, you are using what is called \_\_\_\_\_

harmonic operation

32. Which of the following is the approximate length of a half-wave antenna suitable for use on the 10-meter novice band?

- A. 126 feet.
- B. 66 feet.
- C. 5 feet.
- D. 11 feet.
- E. 17 feet.

F

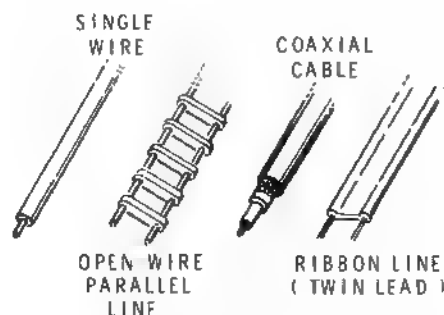
33. Which novice band would a half-wave antenna that is 22 feet long be used on?

- A. 20 meters.
- B. 40 meters.
- C. The 28.1 — 28.2 MHz band.
- D. The 21.1 — 21.2 MHz band.
- E. 10 meters.

D

34. There are several types of transmission lines that are used to connect the transmitter to the antenna.

The three main types of transmission line are the single wire, the open-wire parallel line, and the coaxial cable. These cables are shown in Figure 8-2 along with the ribbon wire type (also called twin lead) which is similar to the open-wire parallel line.



**Figure 8-2**

Probably the most-used type of transmission line in an amateur installation is the coaxial cable type.

List the names of the three main types of transmission line.

single wire, open-wire parallel line, coaxial cable.

35. Which of the following statements concerning harmonic operation is true?

- A. Using a dipole at an even multiple of its normal operating frequency is called harmonic operation.
- B. Using a dipole at less than its normal operating frequency is called harmonic operation.
- C. Using a dipole at an odd multiple of its normal operating frequency is called harmonic operation.
- D. Using a dipole at any frequency that is higher than its normal operating frequency is called harmonic operation.
- E. None of the above.

C

36. Which novice band would a half-wave antenna that is 17 feet long be used on?

- A. 80 meters.
- B. 40 meters.
- C. 20 meters.
- D. 15 meters.
- E. 10 meters.

E

37. As you learned earlier, standing waves are motionless waves of voltage or current on an antenna that are caused by an impedance mismatch.

**The ratio of maximum voltage (or current) to minimum voltage (or current) along a line is called "standing wave ratio (SWR)."**

For best results, the standing wave ratio should be as low as possible (1 to 1).

The ratio of maximum voltage (or current) to minimum voltage (or current) along a line is called \_\_\_\_\_

standing wave ratio

38. Which of the following is a commonly used type of transmission line?

- A. Ribbon wire.
- B. Coaxial cable.
- C. Single wire.
- D. Open-wire parallel line.
- E. All of the above.

E

39. Which of the following statements best describes harmonic operation?

- A. Harmonic operation is the practice of using a dipole antenna at an even multiple of its normal operating frequency.
- B. Harmonic operation is the practice of using a dipole antenna at an odd multiple of its normal operating frequency.
- C. Harmonic operation is the practice of using a dipole antenna at a frequency that is less than its normal operating frequency.
- D. Harmonic operation is the practice of using a dipole antenna at any frequency other than its normal operating frequency.
- E. Harmonic operation is the practice of using a dipole antenna at any frequency that is higher than its normal operating frequency.

B



40. There are several ways that you can determine the SWR on a line. One method is to measure the amounts of maximum and minimum voltage or current along the line and then use them in the following equation:

$$\text{SWR} = \frac{\text{MAX.}}{\text{MIN.}} \text{ (either voltage or current)}$$

The most common method (and the easiest) is to use an SWR bridge (or reflectometer) which measures the forward and reflected values of voltage and indicates the SWR on a meter.

An SWR bridge is simply connected between the transmitter and antenna as shown in Figure 8-3.

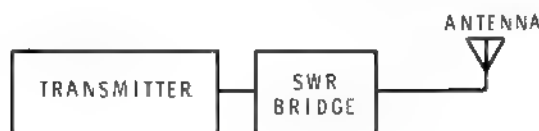


Figure 8-3

The most common method of determining the SWR on a line is to use an \_\_\_\_\_ which measures the forward and reflected values of voltage and indicates the SWR on a meter.

SWR bridge

41. Which of the following statements concerning standing wave ratio is true?

- A. The sum of the maximum voltage (or current) and the minimum voltage (or current) along a line is called standing wave ratio.
- B. The ratio of maximum voltage (or current) to the minimum voltage (or current) along a line is called standing wave ratio.
- C. The difference between the maximum voltage (or current) and the minimum voltage (or current) along a line is called standing wave ratio.
- D. The ratio of maximum voltage to minimum current along a line is called standing wave ratio.
- E. The ratio of maximum current to minimum voltage along a line is called standing wave ratio.

B

42. Which of the following is **not** a commonly used type of transmission line?

- A. Zip cord.
- B. Coaxial cable.
- C. Ribbon wire.
- D. Single wire.
- E. Open-wire parallel line.

A

43. Which of the following instruments is most commonly used to measure SWR?

- A. A voltmeter.
- B. An ammeter.
- C. An SWR bridge.
- D. An ohmmeter.
- E. A VTVM.

C

44. Which of the following best describes standing wave ratio?

- A. Standing wave ratio is a ratio of maximum voltage to minimum current along a line.
- B. Standing wave ratio is a ratio of maximum current to minimum voltage along a line.
- C. Standing wave ratio is the difference between the maximum voltage (or current) and the minimum voltage (or current) along a line.
- D. Standing wave ratio is a ratio of maximum voltage (or current) to the minimum voltage (or current) along a line.
- E. None of the above.

D

45. Which of the following is the most common method of measuring SWR?

- A. With a voltmeter.
- B. With an SWR bridge.
- C. With an ammeter.
- D. With a VTVM.
- E. With an ohmmeter.

B

## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than three questions, go back and re-read this whole module.
  - If you have less than three incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame). Then proceed to the next module.
1. The **electrical** length of an antenna refers to which of the following?
    - A. Its physical length.
    - B. Its length in feet.
    - C. Its length in yards.
    - D. Its length in wavelengths.
    - E. Its length in inches.
  2. Select the true statement concerning antenna input impedance.
    - A. Antenna input impedance is the same at all points along an antenna.
    - B. Antenna input impedance is the same as characteristic impedance.
    - C. Antenna input impedance depends on the impedance of the feedline.
    - D. Antenna input impedance is the impedance of an antenna at the point where the feedline is attached.
    - E. None of the above.
  3. What does characteristic impedance refer to?
    - A. The average impedance of a dipole antenna.
    - B. The impedance at the center of an antenna.
    - C. The average impedance of any antenna.
    - D. The impedance of an antenna and its feedline.
    - E. The impedance of a transmission line.

4. Which of the following best describes a dipole antenna?

- A. A dipole antenna is an antenna which has the signal applied at one end and is usually one-half wave long.
- B. A dipole antenna is an antenna which has the signal applied at both ends and is usually one-half wave long.
- C. A dipole antenna is an antenna which has the signal applied at its center and is usually one-half wave long.
- D. A dipole antenna is an antenna which has the signal applied at its center and is usually one full wave long.
- E. A dipole antenna is an antenna which usually has the signal applied at its center and is two waves long.

5. Select the best definition of a standing wave.

- A. A standing wave is a motionless wave on an antenna that is caused by a perfect match.
- B. A standing wave is a motionless wave on an antenna that is caused by a mismatch.
- C. A standing wave is a moving wave on an antenna that is caused by a perfect match.
- D. A standing wave is a motionless wave on an antenna that causes a perfect match.
- E. A standing wave is a motionless wave on an antenna that causes a mismatch.

6. Select the best description of a transmatch.

- A. A transmatch is an adjustable matching device.
- B. A transmatch matches the output impedance of a transmitter to that of a transmission line.
- C. A transmatch improves the efficiency of an antenna system.
- D. A transmatch attenuates harmonics.
- E. All of the above.

7. Select the correct equation for determining the length of a half-wave antenna.

A.  $L_{(ft)} = \frac{468}{F \text{ (kHz)}}$

B.  $L_{(in)} = \frac{468}{F \text{ (MHz)}}$

C.  $L_{(ft)} = \frac{468}{F \text{ (Hz)}}$

D.  $L_{(ft)} = \frac{468}{F \text{ (MHz)}}$

E.  $F = \frac{468}{L}$

8. Select the approximate length of a half-wave antenna suitable for use on the 80-meter novice band.

- A. 126 feet.
- B. 66 feet.
- C. 80 feet.
- D. 40 feet.
- E. 63 feet.

9. Select the approximate length of a half-wave antenna suitable for use on the 40-meter novice band.

- A. 126 feet.
- B. 40 feet.
- C. 66 feet.
- D. 20 feet.
- E. 33 feet.

10. Select the approximate length of a half-wave antenna suitable for use on the 15-meter novice band.
- A. 15 feet.
  - B. 126 feet.
  - C. 22 feet.
  - D. 66 feet.
  - E. 11 feet.
11. Select the approximate length of a half-wave antenna suitable for use on the 10-meter novice band.
- A. 126 feet.
  - B. 66 feet.
  - C. 5 feet.
  - D. 11 feet.
  - E. 17 feet.
12. Which of the following statements best describes harmonic operation?
- A. Harmonic operation is the practice of using a dipole antenna at an even multiple of its normal operating frequency.
  - B. Harmonic operation is the practice of using a dipole antenna at an odd multiple of its normal operating frequency.
  - C. Harmonic operation is the practice of using a dipole antenna at a frequency that is less than its normal operating frequency.
  - D. Harmonic operation is the practice of using a dipole antenna at any frequency other than its normal operating frequency.
  - E. Harmonic operation is the practice of using a dipole antenna at any frequency that is higher than its normal operating frequency.

13. Which of the following is **not** a commonly used type of transmission line?
- A. Zip cord.
  - B. Coaxial cable.
  - C. Ribbon wire.
  - D. Single wire.
  - E. Open-wire parallel line.
14. Which of the following best describes standing wave ratio?
- A. Standing wave ratio is a comparison of maximum voltage to minimum current along a line.
  - B. Standing wave ratio is a comparison of maximum current to minimum voltage along a line.
  - C. Standing wave ratio is the difference between the maximum voltage (or current) and the minimum voltage (or current) along a line.
  - D. Standing wave ratio is a comparison of maximum voltage (or current) to the minimum voltage (or current) along a line.
  - E. None of the above.
15. Which of the following is the most common method of measuring SWR?
- A. With a voltmeter.
  - B. With an SWR bridge.
  - C. With an ammeter.
  - D. With a VTVM.
  - E. With an ohmmeter.



**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	D	(1)
2.	D	(2)
3.	E	(4)
4.	C	(7)
5.	B	(10)
6.	E	(13)
7.	D	(16)
8.	A	(19)
9.	C	(22)
10.	C	(25)
11.	E	(28)
12.	B	(31)
13.	A	(34)
14.	D	(37)
15.	B	(40)



**Individual Learning Program**

**In**

**AMATEUR RADIO**

**(NOVICE LICENSE)**

**RADIO  
COMMUNICATION  
PRACTICES**





# Individual Learning Program

## AMATEUR RADIO (NOVICE LICENSE)

### *Module 9* RADIO COMMUNICATION PRACTICES ER-3701

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BENTON HARBOR, MICHIGAN 49022

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## MODULE OBJECTIVES

When you complete this module, you will be able to select:

1. The definition of a ground rod.
2. The meaning of "ground potential."
3. The meaning of "plate circuit."
4. The methods of preventing interference with other devices.
5. The meaning of "harmonic radiation."
6. The correct way to connect a voltmeter.
7. The correct way to connect an ammeter.
8. The correct way to connect and use an ohmmeter.
9. The correct way to connect and use a wattmeter.
10. The correct way to determine transmitter input power.
11. The proper sequence of tuning up a transmitter.
12. A method of checking for unwanted harmonics.
13. Four ways to reduce unwanted harmonics.
14. Four methods of preventing electrical shock.
15. The best method of protecting equipment from lightning.

## MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers" which follow.

- If you miss more than three questions, read this whole module.
- If you have less than three incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the practice examinations.

1. Which of the following best describes a ground rod?

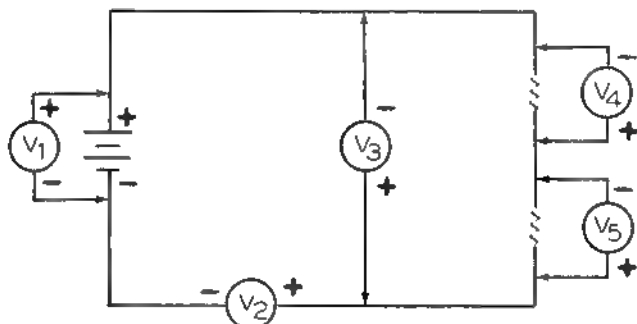
- A. A ground rod is a metal pipe which is driven into the ground to make electrical connection to the earth.
- B. A ground rod is a metal pipe which is attached to a roof for lightning protection.
- C. A ground rod is a non-metallic pipe which is driven into the ground to make an electrical connection to the earth.
- D. A ground rod is a non-metallic pipe which is attached to a roof for lightning protection.
- E. None of the above.

2. Which of the following describes a ground potential?

- A. A ground potential is a term given a metallic object which has zero voltage with respect to the earth.
- B. A ground potential is a term given a non-metallic object which has zero voltage with respect to the earth.
- C. A ground potential is a term given a metallic object which has a negative potential.
- D. A ground potential is a term given a metallic object which has a positive potential.
- E. None of the above.

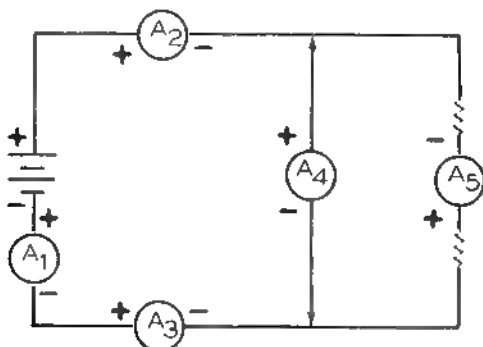
3. Which of the following best describes a "plate circuit?"
  - A. A plate circuit is the internal circuit that is connected between the plate and the cathode of a tube.
  - B. A plate circuit is the external circuit that is connected between the plate and the grid of a tube.
  - C. A plate circuit is the external circuit that is connected between the plate and the cathode of a tube.
  - D. A plate circuit is the internal circuit that is connected between the plate and the grid of a tube.
  - E. A plate circuit is the external circuit that is connected between the grid and the cathode of a tube.
  
4. Which of the following would help prevent interference caused by your transmitter?
  - A. Install a low-pass filter at the transmitter.
  - B. Install a high-pass filter at the receiver being interfered with.
  - C. Check your transmitter for proper adjustment.
  - D. Use equipment of good design.
  - E. All of the above.
  
5. Which of the following best describes harmonic radiation?
  - A. Harmonic radiation is the reception of undesired frequencies.
  - B. Harmonic radiation is the transmission of undesired multiples of a frequency.
  - C. Harmonic radiation is the reception of desired frequencies.
  - D. Harmonic radiation is the transmission of undesired fractions of a frequency.
  - E. None of the above.

6. Which voltmeter in the following circuit is connected properly?



- A.  $V_1$ .
- B.  $V_2$ .
- C.  $V_3$ .
- D.  $V_4$ .
- E.  $V_5$ .

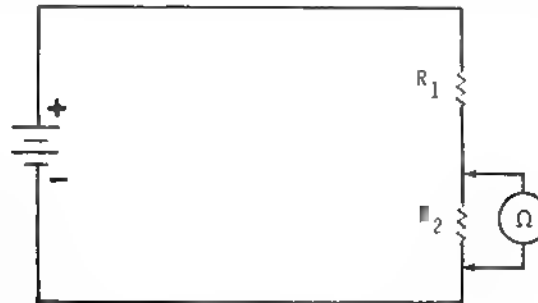
7. Which ammeter in the following circuit is connected properly?



- A.  $A_1$ .
- B.  $A_2$ .
- C.  $A_3$ .
- D.  $A_4$ .
- E.  $A_5$ .



8. What is wrong in the following circuit where the resistance of  $R_2$  is being measured?



- A. The battery polarity is wrong.
  - B. The meter should be connected in parallel with resistor  $R_1$ .
  - C. The meter should be connected in series with resistor  $R_2$ .
  - D. The battery should be disconnected from the circuit.
  - E. Nothing is wrong with the circuit.
9. Which of the following statements concerning wattmeters is true?
- A. Wattmeters are normally connected in series between the transmitter and the antenna.
  - B. Wattmeters are normally connected in parallel between the receiver and the antenna.
  - C. Wattmeters are normally connected in parallel between the transmitter and the antenna.
  - D. To prevent damage to the meter, you should always set the meter to a lower range than you expect to measure.
  - E. You should apply power to the meter first and then select the meter range.

10. What is the input power to the tube in a final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that is operating under the following conditions?

Plate voltage = 800 volts.  
Plate current = 150 milliamperes.  
Screen voltage = 500 volts.  
Screen current = 20 milliamperes.  
Driving power = 2 watts.  
Filament voltage = 12 volts.  
Filament current = 2 amperes.

- A. 120 watts.  
B. 130 watts.  
C. 122 watts.  
D. 156 watts.  
E. 132 watts.
11. Which of the following is the first step you should do to properly tuneup a transmitter?
- A. Adjust the Load control to its minimum setting.  
B. Key the transmitter and quickly adjust the Tune control for a dip.  
C. Connect a dummy load to the transmitter.  
D. Adjust the Drive control for the proper amount of drive.  
E. Adjust the Load control for the rated plate current.
12. Which of the following is an acceptable method of checking for the radiation of harmonics?
- A. Have a friend listen on frequencies that are two and three times higher than your operating frequency.  
B. Have a friend listen on frequencies that are  $1/2$  and  $1/3$  of your operating frequency.  
C. Wait until someone notifies you that you are radiating harmonics.  
D. Have a friend listen on your operating frequency.  
E. None of the above.

13. Which of the following would not help to reduce unwanted harmonics?
- A. Proper shielding.
  - B. Maximum grid drive.
  - C. A transmatch or low-pass filter between the transmitter and antenna.
  - D. An antenna that is resonant only at the operating frequency.
  - E. Minimum grid drive.
14. Which of the following would help prevent electrical shock?
- A. Grounded power cables.
  - B. Keeping antennas and transmission lines away from power lines.
  - C. Equipment that is not exposed to accidental contact.
  - D. Equipment that contains a power transformer.
  - E. All of the above.
15. Which of the following is the **best** method of preventing lightning damage to your equipment?
- A. Cease operating during a lightning storm.
  - B. Use a low antenna.
  - C. Disconnect the antenna from your equipment during a lightning storm.
  - D. Disconnect the antenna from your equipment and then ground the antenna.
  - E. Ground your equipment.

## PRETEST ANSWERS

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	A	(1)
2.	A	(2)
3.	C	(4)
4.	E	(7)
5.	B	(10)
6.	A	(13)
7.	B	(16)
8.	D	(19)
9.	C	(22)
10.	E	(25)
11.	C	(28)
12.	A	(31)
13.	B	(34)
14.	E	(37)
15.	D	(40)

## INTRODUCTION

This module, titled "Radio Communication Practices," deals mostly with test instruments and methods of checking your equipment for proper operation. You will learn how to connect and use the basic types of meters in typical circuits. You will also learn how to check your transmitter for undesirable conditions that could interfere with other receivers.

The subject of safety is covered so you can reduce the possibility of injury to yourself or damage to your equipment.

## PROGRAMMED INSTRUCTION

1. A metal pipe which is driven into the ground to make an electrical connection to the earth is called a "ground rod."

Ground rods are usually made of copper or steel. Copper, however, is preferred because it is a better conductor than steel.

A metal pipe which is driven into the ground to make an electrical connection to the earth is called a \_\_\_\_\_.

ground rod

2. A metallic object which has zero voltage with respect to the earth is said to have a "ground potential."

Many circuits use the metal chassis upon which they are built as a common connection. This common connection is considered "ground" and could be connected to an earth ground without affecting the circuit. In many cases, the chassis is used as the negative (-) side of the circuit.

A metallic object which has zero voltage with respect to the earth is said to have a \_\_\_\_\_.

ground potential.

3. What is a metal pipe which is driven into the ground to make an electrical connection to the earth called?

- A. A common connection.
- B. A ground rod.
- C. A ground potential.
- D. An electrical rod.
- E. A common ground.

B

4. The external circuit that is connected between the plate and the cathode of a tube is called the "plate circuit."

An amplifier plate circuit usually consists of a "load," which can be a component or another circuit, and a power supply.

Figure 9-1 shows a basic tube amplifier circuit. The plate circuit is shown in heavy lines.

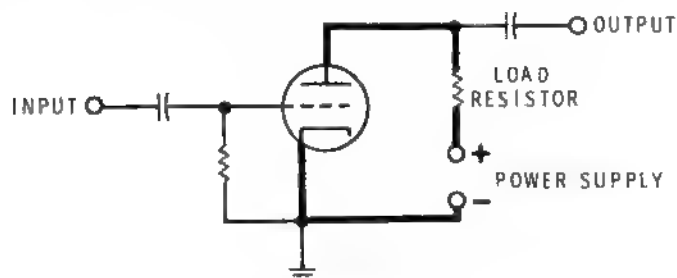


Figure 9-1

The external circuit that is connected between the plate and the cathode of a tube is called the \_\_\_\_\_.

plate circuit

5. A metallic object which has a zero voltage with respect to the earth is said to have which of the following?

- A. A negative potential.
- B. A positive potential.
- C. A zero potential.
- D. A ground potential.
- E. None of the above.

D

6. Which of the following best describes a ground rod?

- A. A ground rod is a metal pipe which is driven into the ground to make an electrical connection to the earth.
- B. A ground rod is a metal pipe which is attached to a roof for lightning protection.
- C. A ground rod is a non-metallic pipe which is driven into the ground to make an electrical connection to the earth.
- D. A ground rod is a non-metallic pipe which is attached to a roof for lightning protection.
- E. None of the above.

A



7. One of the major problems that hams have at one time or another is interference with a neighbor's radio or television set.

The main causes of interference are improperly adjusted transmitters and poor equipment design (either the transmitter or receiver).

The first step in curing an interference problem is to check the transmitter to make sure it is adjusted properly and is operating into the proper antenna.

The second step is to determine if it is your transmitter or the neighbor's receiver which is at fault. You can check this by operating a receiver of good design near your transmitter. If you do not notice interference, the problem is with the neighbor's receiver. If you do notice a problem, the transmitter is probably at fault.

To cure a transmitter problem, install a low-pass filter between the transmitter and the antenna. Always install a low-pass filter as close to the transmitter as practical.

To cure a receiver problem, the neighbor should install a high-pass filter between his receiver and its antenna. Again, this filter should be as close to the receiver as possible. NOTE: Never install a filter on a neighbor's receiver yourself, as he may blame you for any problems that appear later.

To cure an interference problem, check the \_\_\_\_\_ for proper adjustment, install a \_\_\_\_\_-pass filter at the transmitter, install a \_\_\_\_\_-pass filter at the receiver.

transmitter      low      high

8. What is the external circuit that is connected between the plate and the cathode of a tube called?

- A. The cathode circuit.
- B. The plate circuit.
- C. The plate-cathode circuit.
- D. The grid circuit.
- E. The input circuit.

B

9. Which of the following best describes a ground potential?

- A. A ground potential is a term given a metallic object which has zero voltage with respect to earth.
- B. A ground potential is a term given a non-metallic object which has zero voltage with respect to the earth.
- C. A ground potential is a term given a metallic object which has a negative potential.
- D. A ground potential is a term given a metallic object which has a positive potential.
- E. None of the above.

A

10. The transmission of harmonics, multiples of the desired frequency, is called "harmonic radiation."

Usually, harmonic radiation is caused by an improperly adjusted transmitter. To guard against harmonic radiation, use the proper antenna for your operating frequency or install a transmatch (also called an antenna tuner or a matchbox) between your transmitter and antenna. Refer to Module 8 for information about antenna design and the use of a transmatch.

The transmission of harmonics, multiples of the desired frequency, is called \_\_\_\_\_.

harmonic radiation

11. Which of the following would help cure an interference problem?

- A. Install a low-pass filter at the transmitter.
- B. Install a high-pass filter at the receiver being interfered with.
- C. Check your transmitter for proper adjustment.
- D. Use proper equipment design.
- E. All of the above.

E

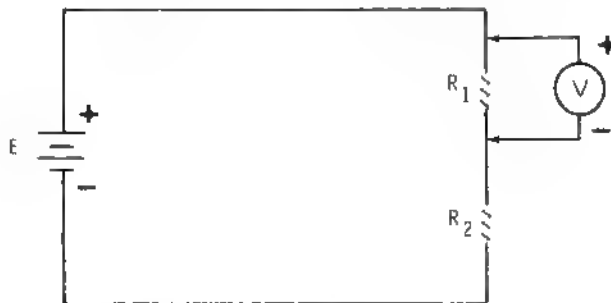
12. Which of the following best describes a plate circuit?

- A. A plate circuit is the internal circuit that is connected between the plate and the cathode of a tube.
- B. A plate circuit is the external circuit that is connected between the plate and the grid of the tube.
- C. A plate circuit is the external circuit that is connected between the plate and the cathode of a tube.
- D. A plate circuit is the internal circuit that is connected between the plate and the grid of a tube.
- E. A plate circuit is the external circuit that is connected between the grid and the cathode of a tube.

C

13. A voltmeter is always connected in parallel with the component you wish to measure the voltage across. Also, the polarity of the meter must match the polarity of the voltage across the component.

Figure 9-2 shows a voltmeter properly connected in a circuit to measure the voltage across resistor  $R_1$ .



**Figure 9-2**

As with any meter, you should always set the meter to a higher range than what you expect to measure before you connect the meter leads.

A voltmeter is always connected in \_\_\_\_\_ with the component you wish to measure the voltage across. Also, the polarity of the meter must \_\_\_\_\_ the polarity of the voltage across the component.

parallel      match

14. What is the transmission of harmonics, multiples of the desired frequency, called?
- A. Multiple radiation.
  - B. Oscillation.
  - C. Multiple transmission.
  - D. Harmonic radiation.
  - E. None of the above.

D

15. Which of the following would **not** help prevent interference with a neighbor's radio or television?

- A. A transmatch on the neighbor's receiver.
- B. A low-pass filter on the transmitter.
- C. A high-pass filter on the neighbor's receiver.
- D. Proper transmitter design.
- E. Proper transmitter adjustment.

A

16. An ammeter is always connected in series with the circuit you wish to measure the current in. The meter must be connected so its positive (+) terminal is toward the positive battery terminal.

Figure 9-3 shows an ammeter properly connected in a circuit to measure the current through the circuit.

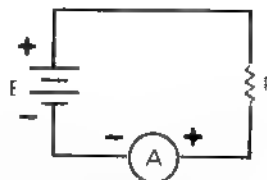
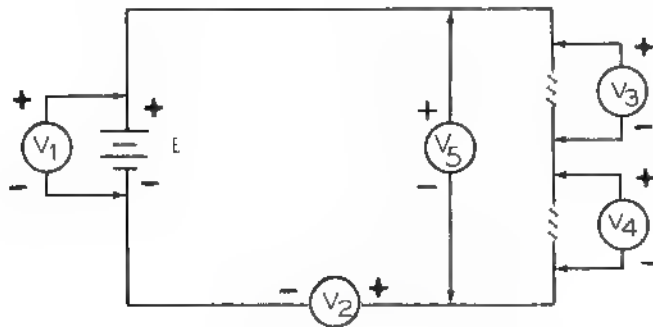


Figure 9-3

An ammeter is always connected in \_\_\_\_\_ with the circuit you wish to measure the current in. The meter must be connected so its positive terminal is \_\_\_\_\_ the positive battery terminal.

series      toward

17. Which voltmeter is **not** connected properly in the following circuit?



- A.  $V_1$ .
- B.  $V_2$ .
- C.  $V_3$ .
- D.  $V_4$ .
- E.  $V_5$ .

B

18. Which of the following best describes harmonic radiation?

- A. Harmonic radiation is the reception of undesired frequencies.
- B. Harmonic radiation is the reception of desired frequencies.
- C. Harmonic radiation is the transmission of undesired multiples of a frequency.
- D. Harmonic radiation is the transmission of undesired fractions of a frequency.
- E. None of the above.

C

19. An ohmmeter is always connected in parallel with the circuit or component you wish to measure the resistance of. NOTE: An ohmmeter must never be connected into a circuit that has voltage applied to it.

Figure 9-4 shows an ohmmeter properly connected to measure a resistor in a circuit.

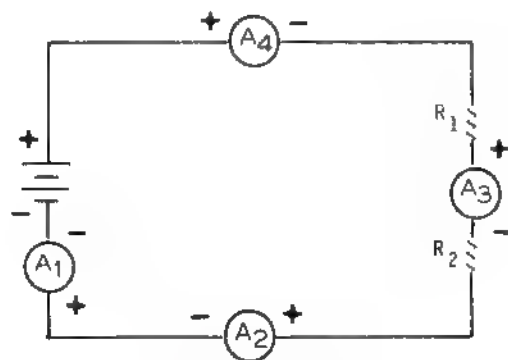


**Figure 9-4**

An ohmmeter is always connected in \_\_\_\_\_ with the circuit or component you wish to measure the resistance of. NOTE: An ohmmeter must never be connected into a circuit that has \_\_\_\_\_ applied to it.

parallel      voltage

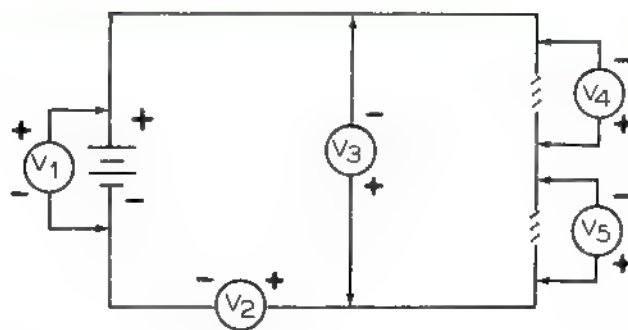
20. Which ammeter is **not** connected properly in the following circuit?



- A. A<sub>1</sub>.
- B. A<sub>2</sub>.
- C. A<sub>3</sub>.
- D. A<sub>4</sub>.
- E. All meters are connected properly.

E

21. Which voltmeter in the following circuit is connected properly?



- A. V<sub>1</sub>.
- B. V<sub>2</sub>.
- C. V<sub>3</sub>.
- D. V<sub>4</sub>.
- E. V<sub>5</sub>.

A



22. There are many types of wattmeters available that you can use to measure the output of your transmitter.

**Wattmeters are normally connected in parallel between the transmitter and antenna. To prevent damage to the meter, always set the meter to a higher range than what you expect to measure before you apply power to the meter.**

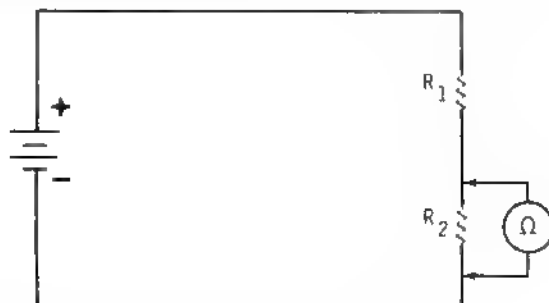
Many wattmeters have a switch so you can measure both forward power (the power going toward the antenna) and reflected power (the power coming back from the antenna, due to a mismatch). You can use these power readings to determine the SWR (standing-wave ratio) of your antenna.

This process is covered in more detail in the following section titled "Operating Aids."

Wattmeters are normally connected in \_\_\_\_\_ between the transmitter and antenna. To prevent damage to the meter, always set the meter to a \_\_\_\_\_ range than what you expect to measure before you apply power to the meter.

parallel      higher

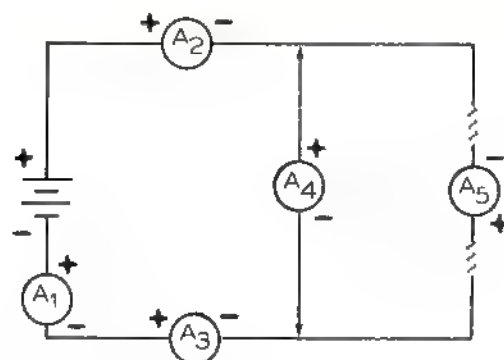
23. What is wrong in the following circuit where the resistance of resistor  $R_2$  is being measured?



- A. The battery polarity is wrong.
- B. The meter should be connected in parallel with resistor  $R_1$ .
- C. The meter should be connected in series with resistor  $R_2$ .
- D. The battery should be disconnected from the circuit.
- E. Nothing is wrong with the circuit.

D

24. Which ammeter in the following circuit is connected properly?



- A.  $A_1$ .
- B.  $A_2$ .
- C.  $A_3$ .
- D.  $A_4$ .
- E.  $A_5$ .

B

25. Transmitter power, as far as an amateur transmitter is concerned, is actually the amount of **input** power to the final amplifier stage. Input power is always greater than the output power (the power coupled to the antenna). In transistor circuits, however, these power levels are much closer than in tube circuits because transistors are more efficient than tubes.

**To determine the amount of input power to the final amplifier stage of a transmitter, you must add the values of plate power, screen (grid) power, and driving power (the power from the previous stage).**

**EXAMPLE:** What is the input power to the tube in a final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that has the following operating conditions:

Plate voltage = 800 volts.

Plate current = 200 milliamperes (.200 amperes).

Screen voltage = 150 volts.

Screen current = 10 milliamperes (.010 amperes).

Filament voltage = 6.3 volts.

Driving power = .75 watts.

**Solution:** Input power = plate power + screen power + driving power.

Input power =  $800 \times .2$  amperes = 160 watts.

$150 \text{ volts} \times .01 \text{ amperes} = 1.5 \text{ watts.}$

Driving power = .75 watts.

Input power =  $160 + 1.5 + .75$

Input power = 162.25 watts (answer)

To determine the input power to the final amplifier stage of a transmitter, you must add the amounts of \_\_\_\_\_ power, \_\_\_\_\_ power, and \_\_\_\_\_ power.

plate

screen

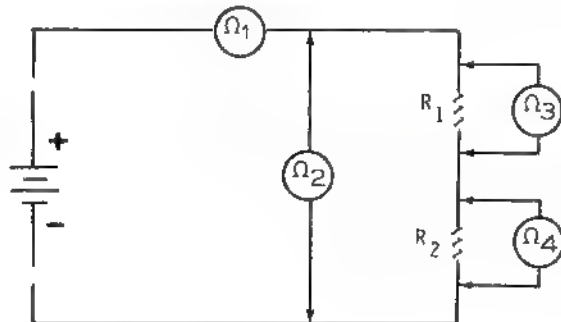
driving

26. Which of the following statements concerning wattmeters is true?

- A. Wattmeters are normally connected in parallel between the transmitter and antenna.
- B. Wattmeters are normally connected in parallel between the receiver and antenna.
- C. Wattmeters are normally connected in series between the transmitter and antenna.
- D. To prevent damage to the meter, you should always set the meter to a lower range than you expect to measure.
- E. You should apply power to the meter first and then select the meter range.

A

27. Which ohmmeter is connected properly in the following circuit to measure the resistance of resistor  $R_1$ ?



- A.  $\Omega_1$ .
- B.  $\Omega_2$ .
- C.  $\Omega_3$ .
- D.  $\Omega_4$ .
- E. None of the meters are connected properly.

C

28. Most transmitters must be “tuned up” for best efficiency on a given frequency before you operate them. The following steps give you a generalized procedure for tuning up a transmitter. You must first determine the proper drive and plate current levels for the specific transmitter involved before you attempt this procedure. Refer to the manual supplied with your transmitter for more information.
1. Connect a dummy load to the transmitter antenna connector.
  2. Adjust the Load control to its minimum setting (maximum capacitance).
  3. Adjust the Drive control to the proper setting.
  4. Key the transmitter and quickly adjust the Tune control for a dip (minimum plate current).
  5. Adjust the Load control for rated plate current for the specific transmitter.
  6. Again, adjust the Tune control for a dip.
  7. Repeat steps 5 and 6 several times until the plate current indicates the specified plate current upon completion of step 6 (fully loaded).
  8. Release the key.

Now, you can replace the dummy load with the antenna and operate the transmitter.

1. Connect a \_\_\_\_\_ load to the transmitter antenna connector.
2. Adjust the Load control to its \_\_\_\_\_ setting.
3. Adjust the \_\_\_\_\_ control for the proper amount of drive.
4. Key the transmitter and quickly adjust the Tune control for a \_\_\_\_\_.
5. Adjust the Load control for rated \_\_\_\_\_ current.
6. Readjust the Tune control for a \_\_\_\_\_.
7. Repeat steps \_\_\_\_\_ and \_\_\_\_\_ until the plate current indicates the specified plate current upon completion of step 6.
8. Release the \_\_\_\_\_.

dummy  
minimum  
Drive  
dip  
plate  
dip  
5, 6  
key

29. What is the input power to the tube in the final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that is operating under the following conditions? \_\_\_\_\_.

Plate voltage = 400 volts.

Plate current = 150 milliamperes (.15 ampere).

Screen voltage = 100 volts.

Screen current = 5 milliamperes (.005 ampere).

Filament voltage = 12 volts.

Filament current = 1 ampere.

Driving power = 500 milliwatts (.5 watt).

61 watts (60 watts + .5 watt + .5 watt)

30. Which of the following statements concerning wattmeters is true?

- A. Wattmeters are normally connected in parallel between the transmitter and antenna.
- B. You should set the meter range before you apply power.
- C. To prevent damage to the meter, you should always set the meter to a higher range than you expect to measure.
- D. All of the above.
- E. None of the above.

D

31. As you learned earlier, harmonics are whole multiples of a given frequency. Although harmonics are sometimes useful **inside** a transmitter, amateurs do not want to **radiate** any harmonic frequencies. Radiation of harmonics can interfere with other stations.

**The easiest method of checking your signal for harmonics is to have another nearby amateur listen to frequencies that are two and three times higher than your actual signal.**

If the other amateur cannot hear you on the second or third harmonic, you may consider your transmitter to be free of harmonics.

The easiest method of checking your signal for harmonics is to have another nearby amateur listen to frequencies that are \_\_\_\_\_ and \_\_\_\_\_ times higher than your actual signal.

two      three



32. The steps in the right hand column below are required to properly tune up a "typical transmitter." Write the letter beside these steps into the blanks in the left hand column in the correct sequence.

- |           |  |
|-----------|--|
| 1.    ___ | A.   Adjust the Load control to its minimum setting.   |
| 2.    ___ | B.   Key the transmitter and quickly adjust the Tune control for a dip.                        |
| 3.    ___ | C.   Connect a dummy load to the transmitter.  |
| 4.    ___ | D.   Adjust the Drive control for the proper amount of drive.                                  |
| 5.    ___ | E.   Adjust the Load control for rated plate current.  |
| 6.    ___ | F.   Release the key.  |
| 7.    ___ | G.   Readjust the Tune control for a dip.  |
| 8.    ___ | H.   Repeat the Load and Tune adjustments several times until the transmitter is fully loaded. |

C  
A  
D  
B  
E  
G  
H  
F

33. What is the input power to the tube in a final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that is operating under the following conditions?

Plate voltage = 500 volts.

Plate current = 175 milliamperes (.175 ampere).

Driving power = 1 watt.

Screen voltage = 300 volts.

Screen current = 20 milliamperes (.02 ampere).

Filament voltage = 6 volts.

Filament current = 2 amperes.

- A. 87.5 watts.
- B. 93.5 watts
- C. 88.5 watts
- D. 7 watts
- E. 94.5 watts

E (87.5 + 1 + 6 = 94.5 watts)

**34.** Improper equipment design is the major cause of harmonics.

**You can eliminate or reduce unwanted harmonics by following these rules:**

- 1. Use minimum grid drive.**
- 2. Use proper shielding.**
- 3. Use a transmatch or low-pass filter between the transmitter and antenna.**
- 4. Use an antenna that is resonant only at the operating frequency.**

**You can eliminate or reduce unwanted harmonics by following these rules:**

- 1. Use minimum \_\_\_\_\_ drive.**
- 2. Use proper \_\_\_\_\_.**
- 3. Use a \_\_\_\_\_ or \_\_\_\_\_-pass filter between the transmitter and antenna.**
- 4. Use an antenna that is resonant only at the \_\_\_\_\_ frequency.**

grid  
shielding  
transmatch      low  
operating

**35.** Which of the following is an acceptable way of checking for the radiation of harmonics?

- A. Have a friend listen on frequencies that are  $1/2$  and  $1/3$  of your operating frequency.**
- B. Have a friend listen on frequencies that are two and three times higher than your operating frequency.**
- C. Have a friend listen on your operating frequency.**
- D. Wait until someone notifies you that you are radiating harmonics.**
- E. None of the above.**

B

36. Which of the following is the first step that you should do to properly tune up a transmitter?

- A. Adjust the Load control to its minimum setting.
- B. Key the transmitter and quickly adjust the Tune control for a dip.
- C. Connect a dummy load to the transmitter.
- D. Adjust the Drive control for the proper amount of drive.
- E. Adjust the Load control for the rated plate current.

C

37. Amateur equipment, like any electrical equipment, always poses a shock hazard.

The following items will help to eliminate the possibility of electrical shock.

- 1. Use equipment that is not exposed to accidental contact.
- 2. Use grounded (three-wire) power cords.
- 3. Use equipment that contains a power transformer.
- 4. Keep antennas and transmission lines away from power lines.
- 5. Use bleeder resistors in power supplies.
- 6. Use equipment that has a safety interlock.

The following items will help to eliminate the possibility of electrical shock.

- 1. Use equipment that is not \_\_\_\_\_ to accidental contact.
- 2. Use \_\_\_\_\_ (three-wire) power cords.
- 3. Use equipment that contains a \_\_\_\_\_.
- 4. Keep antennas and transmission lines away from \_\_\_\_\_ lines.
- 5. Use \_\_\_\_\_ resistors in power supplies.
- 6. Use equipment that has a safety \_\_\_\_\_.

exposed  
grounded  
power transformer  
power  
bleeder  
interlock

38. Which of the following would help to reduce unwanted harmonics?

- A. An antenna that is resonant only at the operating frequency.
- B. Proper shielding.
- C. A transmatch or low-pass filter between the transmitter and antenna.
- D. Minimum grid drive.
- E. All of the above.

E

39. Which of the following is an acceptable method of checking for the radiation of harmonics?

- A. Have a friend listen on frequencies that are two and three times higher than your operating frequency.
- B. Have a friend listen on frequencies that are  $1/2$  and  $1/3$  of your operating frequency.
- C. Wait until someone notifies you that you are radiating harmonics.
- D. Have a friend listen on your operating frequency.
- E. None of the above.

A

40. One of the most potential dangers of an amateur radio installation is lightning.

The obvious prevention of lightning danger is not to operate the station during a lightning storm. This, however, only reduces the chance of the operator from being injured; it does not protect the equipment.

**The best prevention of lightning damage is to disconnect the antenna from your equipment and then ground the antenna.**

The easiest method of grounding an antenna is through a grounding antenna switch. Several brands of satisfactory antenna switches are available from many sources.

The best prevention of lightning damage is to \_\_\_\_\_ the antenna from your equipment and then \_\_\_\_\_ the antenna.

disconnect      ground

41. Which of the following is **not** a method of preventing electrical shock?

- A. Use equipment that is not exposed to accidental contact.
- B. Use grounded power cords.
- C. Keep antennas and transmission lines away from power lines.
- D. Use equipment that does not contain a power transformer.
- E. Use equipment that has a safety interlock.

D

42. Which of the following would not help to reduce unwanted harmonics?

- A. Proper shielding.
- B. Maximum grid drive.
- C. A transmatch or low pass filter between the transmitter and antenna.
- D. An antenna that is resonant only at the operating frequency.
- E. Minimum grid drive.

B

43. Which of the following is the best prevention of lightning danger to equipment?

- A. Disconnect the antenna during a lightning storm.
- B. Cease operation during a lightning storm.
- C. Disconnect the antenna from your equipment and then ground the antenna.
- D. Use a low antenna.
- E. Ground your equipment.

C

44. Which of the following is a good method of preventing electrical shock?

- A. Use grounded power cords.
- B. Keeping antennas and transmission lines away from power lines.
- C. Use equipment that is not exposed to accidental contact.
- D. Use equipment that contains a power transformer.
- E. All of the above.

E

45. Which of the following is the best method of preventing damage to equipment?

- A. Cease operating during a lightning storm.
- B. Use a low antenna.
- C. Disconnect the antenna from your equipment during a lightning storm.
- D. Disconnect the antenna from your equipment and then ground the antenna.
- E. Ground your equipment.

D.



## MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers" which follow.

- If you miss more than three questions, go back and re-read this whole module.
- If you have less than three incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame). Then proceed to the practice examinations.

1. Which of the following best describes a ground rod?

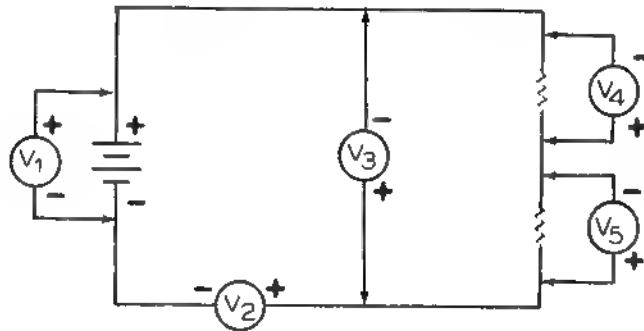
- A. A ground rod is a metal pipe which is driven into the ground to make electrical connection to the earth.
- B. A ground rod is a metal pipe which is attached to a roof for lightning protection.
- C. A ground rod is a non-metallic pipe which is driven into the ground to make an electrical connection to the earth.
- D. A ground rod is a non-metallic pipe which is attached to a roof for lightning protection.
- E. None of the above.

2. Which of the following describes a ground potential?

- A. A ground potential is a term given a metallic object which has zero voltage with respect to the earth.
- B. A ground potential is a term given a non-metallic object which has zero voltage with respect to the earth.
- C. A ground potential is a term given a metallic object which has a negative potential.
- D. A ground potential is a term given a metallic object which has a positive potential.
- E. None of the above.

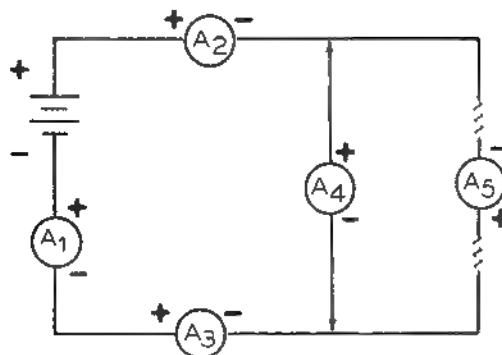
3. Which of the following best describes a "plate circuit?"
- A. A plate circuit is the internal circuit that is connected between the plate and the cathode of a tube.
  - B. A plate circuit is the external circuit that is connected between the plate and the grid of a tube.
  - C. A plate circuit is the external circuit that is connected between the plate and the cathode of a tube.
  - D. A plate circuit is the internal circuit that is connected between the plate and the grid of a tube.
  - E. A plate circuit is the external circuit that is connected between the grid and the cathode of a tube.
4. Which of the following would help prevent interference caused by your transmitter?
- A. Install a low-pass filter at the transmitter.
  - B. Install a high-pass filter at the receiver being interfered with.
  - C. Check your transmitter for proper adjustment.
  - D. Use equipment of good design.
  - E. All of the above.
5. Which of the following best describes harmonic radiation?
- A. Harmonic radiation is the reception of undesired frequencies.
  - B. Harmonic radiation is the transmission of undesired multiples of a frequency.
  - C. Harmonic radiation is the reception of desired frequencies.
  - D. Harmonic radiation is the transmission of undesired fractions of a frequency.
  - E. None of the above.

6. Which voltmeter in the following circuit is connected properly?



- A.  $V_1$ .
- B.  $V_2$ .
- C.  $V_3$ .
- D.  $V_4$ .
- E.  $V_5$ .

7. Which ammeter in the following circuit is connected properly?



- A.  $A_1$ .
- B.  $A_2$ .
- C.  $A_3$ .
- D.  $A_4$ .
- E.  $A_5$ .

8. What is wrong in the following circuit where the resistance of  $R_2$  is being measured?



- A. The battery polarity is wrong.
  - B. The meter should be connected in parallel with resistor  $R_1$ .
  - C. The meter should be connected in series with resistor  $R_2$ .
  - D. The battery should be disconnected from the circuit.
  - E. Nothing is wrong with the circuit.
9. Which of the following statements concerning wattmeters is true?
- A. Wattmeters are normally connected in series between the transmitter and the antenna.
  - B. Wattmeters are normally connected in parallel between the receiver and the antenna.
  - C. Wattmeters are normally connected in parallel between the transmitter and the antenna.
  - D. To prevent damage to the meter, you should always set the meter to a lower range than you expect to measure.
  - E. You should apply power to the meter first and then select the meter range.

10. What is the input power to the tube in a final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that is operating under the following conditions?

Plate voltage = 800 volts.  
Plate current = 150 milliamperes.  
Screen voltage = 500 volts.  
Screen current = 20 milliamperes.  
Driving power = 2 watts.  
Filament voltage = 12 volts.  
Filament current = 2 amperes.

- A. 120 watts.  
B. 130 watts.  
C. 122 watts.  
D. 156 watts.  
E. 132 watts.
11. Which of the following is the first step you should do to properly tuneup a transmitter?
- A. Adjust the Load control to its minimum setting.  
B. Key the transmitter and quickly adjust the Tune control for a dip.  
C. Connect a dummy load to the transmitter.  
D. Adjust the Drive control for the proper amount of drive.  
E. Adjust the Load control for the rated plate current.
12. Which of the following is an acceptable method of checking for the radiation of harmonics?
- A. Have a friend listen on frequencies that are two and three times higher than your operating frequency.  
B. Have a friend listen on frequencies that are  $1/2$  and  $1/3$  of your operating frequency.  
C. Wait until someone notifies you that you are radiating harmonics?  
D. Have a friend listen on your operating frequency.  
E. None of the above.

13. Which of the following would not help to reduce unwanted harmonics?
- A. Proper shielding.
  - B. Maximum grid drive.
  - C. A transmatch or low-pass filter between the transmitter and antenna.
  - D. An antenna that is resonant only at the operating frequency.
  - E. Minimum grid drive.
14. Which of the following would help prevent electrical shock?
- A. Grounded power cables.
  - B. Keep antennas and transmission lines away from power lines.
  - C. Equipment that is not exposed to accidental contact.
  - D. Equipment that contains a power transformer.
  - E. All of the above.
15. Which of the following is the **best** method of preventing lightning damage to your equipment?
- A. Cease operating during a lightning storm.
  - B. Use a low antenna.
  - C. Disconnect the antenna from your equipment during a lightning storm.
  - D. Disconnect the antenna from your equipment and then ground the antenna.
  - E. Ground your equipment.

**EXAMINATION ANSWERS**

<u>Q</u>	<u>A</u>	<u>FRAME NO.</u>
1.	A	(1)
2.	A	(2)
3.	C	(4)
4.	E	(7)
5.	B	(10)
6.	A	(13)
7.	B	(16)
8.	D	(19)
9.	C	(22)
10.	E	(25)
11.	C	(28)
12.	A	(31)
13.	B	(34)
14.	E	(37)
15.	D	(40)

## PRACTICE EXAMINATIONS

These practice examinations will test your knowledge of the material presented in Modules 1 through 9. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Practice Examination Answers" which follows. After you check your answers, go back and study those frames pertaining to the questions you missed (the information in parenthesis, following the correct answer, refers you to the proper frame). Then proceed to the "Final Examination."

### PRACTICE EXAMINATION #1

1. Which of the following segments is authorized for novice use?

- A. 3.7 — 3.75 MHz.
- B. 7.1 — 7.15 MHz.
- C. 21.1 — 21.2 MHz.
- D. 28.1 — 28.2 MHz.
- E. All of the above.

2. What type of emission may a novice use?

- A. A1.
- B. AØ
- C. F1.
- D. F2.
- E. F3.

3. What is the maximum power a novice may use?

- A. 1000 watts output.
- B. 250 watts output.
- C. 1000 watts input.
- D. 250 watts input.
- E. 100 watts.



4. What is the wavelength of 15,000 kHz?
- A. 20 meters.
  - B. .2 meters.
  - C. 2 meters.
  - D. 200 meters.
  - E. 2000 meters.
5. What is the frequency 7100 kHz in MHz?
- A. 71 MHz.
  - B. 7.1 MHz.
  - C. 710 MHz.
  - D. 40 MHz.
  - E. .71 MHz.
6. What does QRS? mean?
- A. You are sending too fast.
  - B. Who is calling me?
  - C. Am I sending too fast?
  - D. Do you have anything for me?
  - E. Am I being interfered with?
7. Which of the following is the abbreviation for Universal Coordinated Time?
- A. EST.
  - B. UTC.
  - C. GMT.
  - D. UCT.
  - D. Zulu.
8. What type of emission is an interrupted, unmodulated carrier wave?
- A. A~~ø~~.
  - B. A2.
  - C. A1.
  - D. F1.
  - E. F2.

9. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

- A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
- B. The carrier wave must be as constant as the state of the art permits.
- C. The carrier wave may vary in frequency as long as it starts within an amateur band.
- D. The carrier wave may vary in frequency as long as it stays within an amateur band.
- E. None of the above.

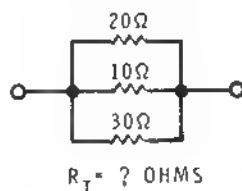
10. Select the best definition of current.

- A. A difference of potential.
- B. The opposition of the flow of electrons.
- C. The ability to store electrical energy.
- D. The amount of electrons flowing through a circuit.
- E. The ability to store magnetic energy.

11. What is the unit of measurement for current?

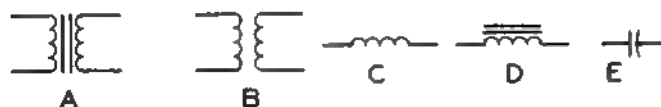
- A. The watt.
- B. The ohm.
- C. The volt.
- D. The henry.
- E. The ampere.

12. What is the total resistance of the following circuit?

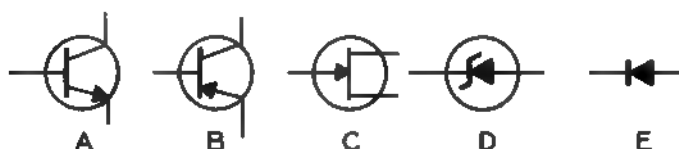


- A.  $60\Omega$ .
- B.  $5.45\Omega$ .
- C.  $12\Omega$ .
- D.  $7.5\Omega$ .
- E.  $6.67\Omega$ .

13. Select the symbol of an iron core transformer.



14. Which of the following is the symbol of a PNP transistor?

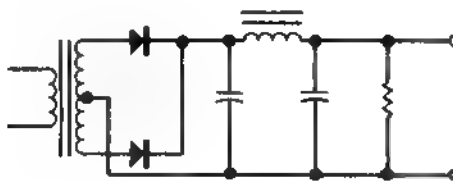


15. What does the following block diagram represent?



- A. A simple receiver.
- B. A key click filter.
- C. A basic amplifier.
- D. A simple transmitter.
- E. A low-pass filter.

16. What kind of circuit is shown below?



- A. A half-wave rectifier circuit
- B. A full-wave rectifier circuit.
- C. A key click filter.
- D. A full-wave regulator circuit.
- E. An oscillator circuit.

17. Select the approximate length of a half-wave antenna suitable for use on the 15-meter novice band.

- A. 15 feet.
- B. 126 feet.
- C. 22 feet.
- D. 66 feet.
- E. 11 feet.

18. The electrical length of an antenna refers to which of the following?

- A. Its physical length.
- B. Its length in feet.
- C. Its length in yards.
- D. Its length in wavelengths.
- E. Its length in inches.

19. What is the input power to the tube in a final amplifier stage of a transmitter (exclusive of the power used to heat the cathode) that is operating under the following conditions?

Plate voltage = 800 volts.  
Plate current = 150 milliamperes.  
Screen voltage = 500 volts.  
Screen current = 20 milliamperes.  
Driving power = 2 watts.  
Filament voltage = 12 volts.  
Filament current = 2 amperes.

- A. 124 watts.
- B. 130 watts.
- C. 122 watts.
- D. 156 watts.
- E. 132 watts.

20. Which of the following is the first step you should do to properly tune up a transmitter?

- A. Adjust the Load control to its minimum setting.
- B. Key the transmitter and quickly adjust the Tune control for a dip.
- C. Connect a dummy load to the transmitter.
- D. Adjust the Drive control for the proper amount of drive.
- E. Adjust the Load control for the rated current.

**PRACTICE EXAMINATION #2**

1. How long must you retain your station log after the last entry?
  - A. Five years.
  - B. Six months.
  - C. Two years.
  - D. Indefinitely.
  - E. One year.
  
2. How long do you have to answer a Notice of Violation?
  - A. Ten hours.
  - B. Two weeks.
  - C. One month.
  - D. Ten days.
  - E. One day.
  
3. Which of the following is true concerning a novice license?
  - A. License is good for two years, renewable.
  - B. License is good for one year, non-renewable.
  - C. License is good for one year, renewable.
  - D. License is good for five years, renewable.
  - E. License is good for two years, non-renewable.
  
4. What is the layer of ionized gases above the earth called.
  - A. The 50-mile layer.
  - B. The ionosphere.
  - C. The radio region.
  - D. The troposphere.
  - E. The atmosphere.
  
5. What is the 11-year cycle which causes changes in the layers of the ionosphere called?
  - A. The atmospheric cycle.
  - B. The wavelength.
  - C. The sunspot cycle.
  - D. The 11-year cycle.
  - E. The ionospheric cycle.

6. What is a Q signal?
- A. A secret code.
  - B. A report of signal quality.
  - C. A call for any station to answer.
  - D. A type of abbreviation for common messages and questions.
  - E. A distress call.
7. Which of the following is the best signal report?
- A. 599.
  - B. 579K.
  - C. 599X.
  - D. 599C.
  - E. 111.
8. Which of the following is the best place to key a transmitter?
- A. A stage after the oscillator circuit.
  - B. The oscillator circuit.
  - C. A stage in front of the oscillator circuit.
  - D. The antenna.
  - E. The main power supply.
9. Which of the following is characteristic of a good quality A1 emission?
- A. The emission should have many spurious emissions and a pure note.
  - B. The emission should be free of spurious emissions and have a pure note.
  - C. The emission should have many clicks and a pure note.
  - D. The emission should have much chirp and a pure note.
  - E. None of the above.

10. What is the unit of measurement for resistance?

- A. The farad.
- B. The watt.
- C. The volt.
- D. The ohm.
- E. The ampere.

11. What is the battery voltage in the following circuit?



- A. Can't determine.
- B. 105 volts.
- C. 180 volts.
- D. 75 volts.
- E. 43.7 volts.

12. What type of tube is shown below?

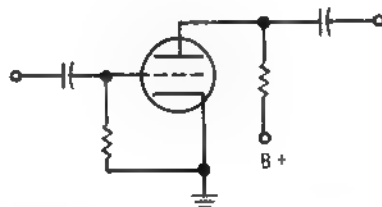


- A. Pentode.
- B. Triode.
- C. Heptode.
- D. Diode.
- E. Tetrode.

13. Select the true statement concerning current flow in a vacuum tube.

- A. Current flows from grid to plate.
- B. Current flows from grid to cathode.
- C. Current flows from plate to cathode.
- D. Current flows from cathode to plate.
- E. Current flows from plate to grid.

14. What kind of circuit is shown below?



- A. A basic oscillator circuit.
- B. A basic amplifier circuit.
- C. A low-pass filter.
- D. A full-wave rectifier circuit.
- E. A half-wave rectifier circuit.

15. Which of the following statements is true concerning the purpose of a high-pass filter?

- A. The purpose of a high-pass filter is to pass signals below a certain frequency but block higher frequency signals.
- B. The purpose of a high-pass filter is to block signals above a certain frequency but pass lower frequency signals.
- C. The purpose of a high-pass filter is to pass signals above a certain frequency but block signals below this frequency.
- D. All of the above are true.
- E. None of the above are true.

16. Select the approximate length of a half-wave antenna suitable for the 40-meter novice band.

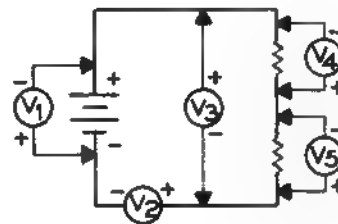
- A. 126 feet.
- B. 40 feet.
- C. 20 feet.
- D. 33 feet.
- E. 66 feet.



17. Which of the following is not a commonly used type of transmission line?

- A. Zip cord.
- B. Coaxial cable.
- C. Ribbon wire.
- D. Single wire.
- E. Open-wire parallel line.

18. Which voltmeter in the following circuit is connected properly?



- A.  $V_1$ .
- B.  $V_2$ .
- C.  $V_3$ .
- D.  $V_4$ .
- E.  $V_5$ .

19. Which of the following would help prevent interference caused by your transmitter?

- A. Install a low-pass filter at the transmitter.
- B. Install a high-pass filter at the receiver being interfered with.
- C. Check your transmitter for proper adjustment.
- D. Use equipment of good design.
- E. All of the above.

20. Which of the following would not help to reduce unwanted harmonics?

- A. The use of proper shielding.
- B. The use of maximum grid drive.
- C. The use of a transmatch or low-pass filter between the transmitter and antenna.
- D. The use of an antenna that is resonant only at the operating frequency.
- E. The use of minimum grid drive.

**PRACTICE EXAMINATION ANSWERS****Examination #1**

Q	A	REFERENCE
1	E	Module 1, Frames 19, 22, 25, and 28.
2	A	Module 1; Frame 31.
3	D	Module 1; Frame 34.
4	A	Module 2; Frame 37.
5	B	Module 2; Frame 16.
6	C	Module 3; Frame 10.
7	B	Module 3; Frame 49.
8	C	Module 4; Frame 19.
9	B	Module 4; Frame 31.
10	D	Module 5; Frame 1.
11	E	Module 5; Frame 43.
12	B	Module 5; Frame 73.
13	A	Module 6; Frame 10.
14	B	Module 6; Frame 22.
15	D	Module 7; Frame 4.
16	B	Module 7; Frame 22.
17	C	Module 8; Frame 25.
18	D	Module 8; Frame 1.
19	E	Module 9; Frame 25.
20	C	Module 9; Frame 28.

**Examination #2**

Q	A	REFERENCE
1	E	Module 1; Frame 65.
2	D	Module 1; Frame 74.
3	E	Module 1; Frame 38.
4	B	Module 2; Frame 1.
5	C	Module 2; Frame 13.
6	D	Module 3; Frame 4.
7	C	Module 3; Frame 25.
8	A	Module 4; Frame 25.
9	B	Module 4; Frame 22.
10	D	Module 5; Frame 46.
11	C	Module 5; Frame 79.
12	A	Module 6; Frame 25.
13	D	Module 6; Frame 28.
14	B	Module 7; frame 1.
15	C	Module 7; Frame 16.
16	E	Module 8; Frame 22.
17	A	Module 8; Frame 34.
18	C	Module 9; Frame 13.
19	E	Module 9; Frame 7.
20	II	Module 9; Frame 34.



**Individual Learning Program**

**In**

**AMATEUR RADIO**  
(NOVICE LICENSE)

OPERATING AIDS





# **Individual Learning Program**

## **AMATEUR RADIO** (NOVICE LICENSE)

### **OPERATING AIDS** ER-3701

**HEATH COMPANY**  
BENTON HARBOR, MICHIGAN 49022

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## **GENERAL INFORMATION**

The information in this section of your Course is not required to pass the novice test. It is only included as a convenient reference source.

Any wires, insulators, etc., mentioned on the following pages are usually available from local electronics distributors as well as many other sources.



## COMMON ABBREVIATIONS

ABT	About	NR	Number
ADR	Address	OB	Old boy
AGN	Again	OM	Old man (not derogatory to hams)
ANT	Antenna	OP, OPR	Operator
BCI	Broadcast interference	OT	Old timer
BK	Break	PSE	Please
BUG	Semi-automatic telegraph key	PWR	Power
C	Yes, correct	R	Roger
CFM	Confirm	RCVD, RCD	Received
CL	Closing station	RCVR, RX	Receiver
CLD, CLG	Called, calling	RFI	Radio frequency interference
CQ	Calling any station	RIG	Transmitter
CUD	Could	RPT	Repeat
CUL	See you later	RTTY	Radiotelegraph
CW	Continuous wave (telegraph)	SASE	Self-address, stamped envelope
DE	From	SED	Said
DX	Distance, distant	SIG	Signal
ES	And	SKED	Schedule
FB	Fine business (good)	SRI	Sorry
GA	Good afternoon	TNX	Thanks
GB	Good-bye	TVI	Television interference
GE	Good evening	UR, URS	Your, your're, yours
GM	Good morning	VFO	Variable frequency oscillator
GN	Good night	VY	Very
GND	Ground	WAT	What
GUD	Good	WKD, WKG	Worked, working
HI	Telegraphic laughter	WUD	Would
HR	Here	WX	Weather
HV	Have	XMTR, TX	Transmitter
HW	How	XTAL	Crystal
LID	A poor operator	XYL	Ex young lady (wife)
MA, MILS	Milliamperes	YL	Young lady (not married)
MSG	Message	73	Best regards
NIL	Nothing	88	Love and kisses

## TWELVE MOST COMMON Q SIGNALS

NOTE: A Q signal by itself is a statement. A Q signal followed by a question mark is a question.

Q SIGNAL	STATEMENT	QUESTION
QRA	The name of my station is . . . . .	What is the name of your station?
QRM	You are being interfered with . . . . .	Am I being interfered with?
QRN	I am troubled by static.	Are you troubled by static?
QRQ	You are sending too slow.	Am I sending too slow?
QRS	You are sending too fast.	Am I sending too fast?
QRT	I am going to stop sending.	Are you going to stop sending?
QRX	I will call again at . . . . . (time).	When will you call again?
QRZ	You are being called by . . . . .	Who is calling me?
QSB	Your signals are fading.	Are my signals fading?
QSL	I acknowledge receipt.	Can you acknowledge receipt?
QSY	I am changing frequency.	Are you going to change frequency?
QTH	My location is . . . . .	What is your location?

## MAKING YOUR OWN ANTENNA

One of the more common antennas that beginners use is the dipole, or half-wave antenna. The following information will show you how to construct your own dipole antenna. The length of antenna wire that you need depends on the band you make the antenna for. The length of coaxial cable you need depends on your particular installation.

Refer to Figure 10-1 and construct the antenna as shown. Table 1 shows you how long dimension A should be for each novice band. If you are not sure which novice band to use, construct the antenna for the 40-meter band. A 40-meter antenna can be used on both 40 and 15 meters and is the most practical. NOTE: Be sure to measure dimension A as accurately as possible so it will be the correct length **after** you wrap the wire around the insulator and solder it.

TABLE 1

NOVICE BAND	DIMENSION A
80 meters (3700-3750 kHz)	62'9"
40 meters (7100-7150 kHz)	32'9"
15 meters (21,100-21,200 kHz)	11'
10 meters (28,100-28,200 kHz)	8'3"

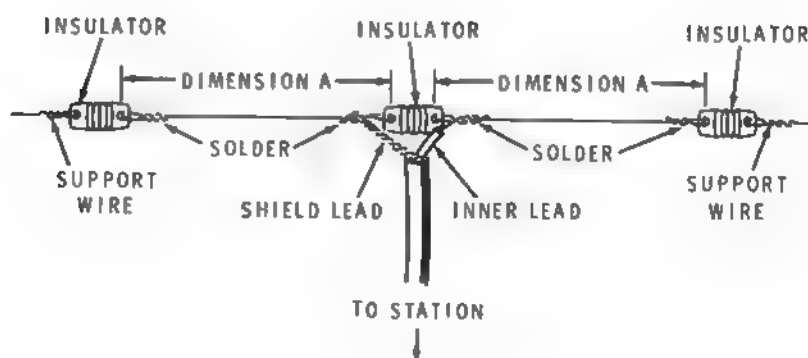


Figure 10-1

## **SPECIAL CONSIDERATIONS**

There are a number of things you should consider as you think about an ideal location for your antenna. Antenna location is quite important since it affects the results you will get. Plan its location carefully and consider the following antenna requirements.

1. A dipole antenna works best off its sides and poorest off its ends.
2. The coaxial cable from your antenna must be connected to your station. Also, you should provide a ground lead from a cold water pipe to your station. This means the location of your station in your home will be affected by the antenna location you select and the availability of a cold water pipe or equivalent ground object from which to run a ground wire.
3. Two tall objects are required (buildings, trees, poles, etc.) for hanging the antenna.
4. The antenna should be kept away from power lines, rain gutters, metal buildings, or other large metal objects that might block, shield, or absorb signals (or cause interference).

## INTERNATIONAL PREFIXES

This chart shows how call letter prefixes are assigned throughout the world.

A2A-A2Z	Republic of Botswana	HAA-HAZ	Hungarian People's Republic
A3A-A3Z	Kingdom of Tonga	HBA-HBZ	Switzerland
A4A-A4Z	Oman	HCA-HDZ	Ecuador
A5A-A5Z	Bhutan	HEA-HEZ	Switzerland
A6A-A6Z	United Arab Emirates	HFA-HFZ	People's Republic of Poland
AAA-ALZ	United States of America	HGA-HGZ	Hungarian People's Republic
AMA-AOZ	Spain	HHA-HHZ	Republic of Haiti
APA-ASZ	Pakistan	HIA-HIZ	Dominican Republic
ATA-AWZ	India	HJA-HKZ	Republic of Colombia
AXA-AXZ	Commonwealth of Australia	HLA-HMZ	Korea
AYA-AZZ	Argentine Republic	HNA-HNZ	Iraq
BAA-BZZ	China	HOA-HPZ	Republic of Panama
C2A-C2Z	Republic of Nauru	HQA-HRZ	Republic of Honduras
C3A-C3Z	Principality of Andorra	HSA-HSZ	Thailand
CAA-CEZ	Chile	HTA-HTZ	Nicaragua
CFA-CKZ	Canada	HUA-HUZ	Republic of El Salvador
CLA-CMZ	Cuba	HVA-HVZ	Vatican City State
CNA-CNZ	Morocco	HWA-HYZ	France and French Community
COA-COZ	Cuba	HZA-HZZ	Saudi Arabia
CPA-CPZ	Bolivia	IAA-IZZ	Italy
CQA-CRZ	Portuguese Overseas Provinces	JAA-JSZ	Japan
CSA-CUZ	Portugal	JTA-JVZ	Mongolian People's Republic
CVA-CXZ	Uruguay	JWA-JXZ	Norway
CYA-CZZ	Canada	JYA-JYZ	Jordan
DAA-DTZ	Germany	JZA-JZZ	Western New Guinea
DUA-DZZ	Republic of the Philippines	KAA-KZZ	United States of America
EAA-EHZ	Spain	L2A-L9Z	Argentina
EIA-EJZ	Ireland	LAA-LNZ	Norway
EKA-EKZ	Union of Soviet Socialist Reps.	LOA-LWZ	Argentine Republic
ELA-ELZ	Liberia	LXA-LXZ	Luxembourg
EMA-EOZ	Union of Soviet Socialist Reps.	LYA-LYZ	Lithuania
EPA-EQZ	Iran	LZA-LZZ	People's Republic of Bulgaria
ERA-ERZ	Union of Soviet Socialist Reps.	MAA-MZZ	United Kingdom
ESA-ESZ	Estonia	NAA-NZZ	United States of America
ETA-ETZ	Ethiopia	OAA-OCZ	Peru
EUA-EWZ	Byelorussian Soviet Socialist Rep.	ODA-ODZ	Lebanon
EXA-EZZ	Union of Soviet Socialist Reps.	OEA-OEZ	Austria
FAA-FZZ	France and French Community	OFA-OJZ	Finland
GAA-GZZ	United Kingdom	OKA-OMZ	Czechoslovakia

ONA-OTZ	Belgium	VZA-VZZ	Commonwealth of Australia
OUA-OZZ	Denmark	WAA-WZZ	United States of America
PAA-PIZ	Netherlands	XAA-XIZ	Mexico
PJA-PJZ	Netherlands Antilles	XJA-XOZ	Canada
PKA-POZ	Republic of Indonesia	XPA-XPZ	Denmark
PPA-PYZ	Brazil	XQA-XRZ	Chile
PZA-PZZ	Surinam	XSA-XSZ	China
QAA-QZZ	(Service abbreviations)	XTA-XTZ	Republic of the Upper Volta
RAA-RZZ	Union of Soviet Socialist Reps.	XUA-XUZ	Khmer Republic
S2A-S3Z	Bangladesh	XVA-XVZ	Vietnam
SAA-SMZ	Sweden	XWA-XWZ	Laos
SNA-SRZ	People's Republic of Poland	XXA-XXZ	Portuguese Overseas Provinces
SSA-SSM	United Arab Republic	XYA-XZZ	Burma
SUA-SUZ	Arab Republic of Egypt	YAA-YAZ	Afganistan
SVA-SZZ	Greece	YBA-YHA	Republic of Indonesia
TAA-TCZ	Turkey	YIA-YIZ	Iraq
TDA-TDZ	Guatemala	YJA-YJZ	New Hebrides
TEA-TEZ	Costa Rica	YKA-YKZ	Syria
TFA-TFZ	Iceland	YLA-YLZ	Latvia
TGA-TGZ	Guatemala	YMA-YMZ	Turkey
THA-THZ	France and French Community	YNA-YNZ	Nicaragua
TIA-TIZ	Costa Rica	YOA-YRZ	Romanian People's Republic
TJA-TJZ	Republic of Cameroon	YSA-YSZ	Republic of El Salvador
TKA-TKZ	France and French Community	YTA-YUZ	Yugoslavia
TLA-TLZ	Central African Republic	YVA-YTZ	Venezuela
TMA-TMZ	France and French Community	YZA-YZZ	Yugoslavia
TNA-TNZ	Republic of Congo (Brazzaville)	ZAA-ZAZ	Albania
TOA-TQZ	France and French Community	ZBA-ZJZ	British Overseas Territories
TRA-TRZ	Republic of Gabon	ZKA-ZMZ	New Zealand
TSA-TSZ	Tunisia	ZNA-ZOZ	British Overseas Territories
TTA-TTZ	Republic of Chad	ZPA-ZPZ	Paraguay
TUA-TUZ	Republic of the Ivory Coast	ZQA-ZQZ	British Overseas Territories
TVA-TXZ	France and French Community	ZRA-ZUZ	Republic of South Africa
TYA-TYZ	Republic of Dahomey	ZVA-ZZZ	Brazil
TZA-TZZ	Republic of Mali	2AA-2ZZ	Great Britain
UAA-UQZ	Union of Soviet Socialist Reps.	3AA-3AZ	Monaco
URA-UTZ	Ukrainian Soviet Socialist Rep.	3BA-3BZ	Mauritius
UUA-UZZ	Union of Soviet Socialist Reps.	3CA-3CZ	Equatorial Guinea
VAA-VGZ	Canada	3DA-3DM	Swaziland
VHA-VNZ	Commonwealth of Australia	3DN-3DZ	Fiji
VOA-VOZ	Canada	3DN-3FZ	Panama
VPA-VSZ	British Overseas Territories	3GA-3GZ	Chile
VTA-VWZ	India	3HA-3UZ	China
VXA-VYZ	Canada	3VA-3VZ	Tunisia

3WA-3WZ	Vietnam	6VA-6WZ	Republic of the Senegal
3XA-3XZ	Guinea	6XA-6XZ	Malagasy Republic
3YA-3YZ	Norway	6YA-6YZ	Jamaica
3ZA-3ZZ	People's Republic of Poland	6ZA-6ZZ	Liberia
4AA-4CZ	Mexico	7AA-7IZ	Indonesia
4DA-4IZ	Republic of the Philippines	7JA-7NZ	Japan
4JA-4LZ	Union of Soviet Socialist Reps.	7OA-7OZ	South Yemen Popular Republic
4MA-4MZ	Venezuela	7PA-7PZ	Lesotho
4NA-4OZ	Yugoslavia	7QA-7QZ	Malawi
4PA-4SZ	Ceylon	7RA-7RZ	Algeria
4UA-4UZ	United Nations	7SA-7SZ	Sweden
4VA-4VZ	Republic of Haiti	7TA-7YZ	Algeria
4WA-4WZ	Yemen	7ZA-7ZZ	Saudi Arabia
4XA-4XZ	State of Israel	8AA-8IZ	Indonesia
4YA-4YZ	International Civil Aviation Org.	8JA-8NZ	Japan
4ZA-4ZZ	State of Israel	8OA-8OZ	Botswana
5AA-5AZ	Libya	8PA-8PZ	Barbados
5BA-5BZ	Republic of Cyprus	8QA-8QZ	Maldiv Islands
5CA-5GZ	Morocco	8RA-8RZ	Guyana
5HA-5IZ	Tanzania	8SA-8SZ	Sweden
5JA-5KZ	Colombia	8TA-8YZ	India
5LA-5MZ	Liberia	8ZA-8ZZ	Saudi Arabia
5NA-5OZ	Nigeria	9AA-9AZ	San Marino
5PA-5QZ	Denmark	9BA-9DZ	Iran
5RA-5SZ	Malagasy Republic	9EA-9FZ	Ethiopia
5TA-5TZ	Islamic Republic of Mauritania	9GA-9GZ	Ghana
5UA-5UZ	Republic of the Niger	9HA-9HZ	Malta
5VA-5VZ	Togolese Republic	9IA-9JZ	Zambia
5WA-5WZ	Western Samoa	9KA-9KZ	Kuwait
5YA-5ZZ	Uganda	9LA-9LZ	Sierra Leone
5XA-5XZ	Kenya	9MA-9MZ	Malaysia
6AA-6BZ	Arab Republic of Egypt	9NA-9NZ	Nepal
6CA-6CZ	Syria	9OA-9TZ	Republic of Zaire
6DA-6JZ	Mexico	9UA-9UZ	Burundi
6KA-6NZ	Korea	9VA-9VZ	Singapore
6OA-6OZ	Somalia	9WA-9WZ	Malaysia
6PA-6SZ	Pakistan	9XA-9XZ	Rwanda
6TA-6UZ	Sudan	9YA-9ZZ	Trinidad and Tobago

## MORSE CODE CHARACTERS

A Di-dah  
 B Dah-di-di-dit  
 C Dah-di-dah-dit  
 D Dah-di-dit  
 E Dit  
 F Di-di-dah-dit  
 G Dah-dah-dit  
 H Di-di-di-dit  
 I Di-dit  
 J Di-dah-dah-dah  
 K Dah-di-dah  
 L Di-dah-di-dit  
 M Dah-dah  
 N Dah-dit  
 O Dah-dah-dah  
 P Di-dah-dah-dit  
 Q Dah-dah-di-dah  
 R Di-dah-dit  
 S Di-di-dit  
 T Dah  
 U Di-di-dah  
 V Di-di-di-dah  
 W Di-dah-dah  
 X Dah-di-di-dah  
 Y Dah-di-dah-dah  
 Z Dah-dah-di-dit

1 Di-dah-dah-dah-dah  
 2 Di-di-dah-dah-dah  
 3 Di-di-di-dah-dah  
 4 Di-di-di-di-dah  
 5 Di-di-di-di-dit  
 6 Dah-di-di-di-dit  
 7 Dah-dah-di-di-dit  
 8 Dah-dah-dah-di-dit  
 9 Dah-dah-dah-dah-dit  
 0 Dah-dah-dah-dah-dah

Period	Di-dah-di-dah-di-dah
Comma	Dah-dah-di-di-dah-dah
Question Mark	Di-di-dah-dah-di-dit
Fraction bar	Dah-di-di-dah-dit
Parenthesis	Dah-di-dah-dah-di-dah
Quotation marks	Di-dah-di-di-dah-dit
Colon	Dah-dah-dah-di-di-dit
Semicolon	Dah-di-dah-di-dah-dit
Hyphen	Dah-di-di-di-di-dah
Dollar Sign	Di-di-di-dah-di-di-dah

Wait ( $\overline{AS}$ )	Di-dah-di-di-dit
Break ( $\overline{BT}$ )	Dah-di-di-di-dah
End of Message ( $\overline{AR}$ )	Di-dah-di-dah-dit
End of Transmission ( $\overline{VA}$ )	Di-di-di-dah-di-dah
Received okay (R)	Di-dah-dit
Invitation to Transmit (K)	Dah-di-dah



**TIME ZONE CROSS REFERENCE**

UTC (Universal Coordinated Time)	EST (Eastern Standard Time)	CST (Central Standard Time)	MST (Mountain Standard Time)	PST (Pacific Standard Time)
0000	1900	1800	1700	1600
0100	2000	1900	1800	1700
0200	2100	2000	1900	1800
0300	2200	2100	2000	1900
0400	2300	2200	2100	2000
0500	0000	2300	2200	2100
0600	0100	0000	2300	2200
0700	0200	0100	0000	2300
0800	0300	0200	0100	0000
0900	0400	0300	0200	0100
1000	0500	0400	0300	0200
1100	0600	0500	0400	0300
1200	0700	0600	0500	0400
1300	0800	0700	0600	0500
1400	0900	0800	0700	0600
1500	1000	0900	0800	0700
1600	1100	1000	0900	0800
1700	1200	1100	1000	0900
1800	1300	1200	1100	1000
1900	1400	1300	1200	1100
2000	1500	1400	1300	1200
2100	1600	1500	1400	1300
2200	1700	1600	1500	1400
2300	1800	1700	1600	1500

## WORKED ALL STATES CHECK LIST

This check list allows you to keep a record of the  
states worked (W) and confirmed (C).

### FIRST CALL AREA

	W	C
Connecticut	<input type="checkbox"/>	<input type="checkbox"/>
Maine	<input type="checkbox"/>	<input type="checkbox"/>
Massachusetts	<input type="checkbox"/>	<input type="checkbox"/>
New Hampshire	<input type="checkbox"/>	<input type="checkbox"/>
Rhode Island	<input type="checkbox"/>	<input type="checkbox"/>
Vermont	<input type="checkbox"/>	<input type="checkbox"/>

### FIFTH CALL AREA

	W	C
Arkansas	<input type="checkbox"/>	<input type="checkbox"/>
Louisiana	<input type="checkbox"/>	<input type="checkbox"/>
Mississippi	<input type="checkbox"/>	<input type="checkbox"/>
New Mexico	<input type="checkbox"/>	<input type="checkbox"/>
Oklahoma	<input type="checkbox"/>	<input type="checkbox"/>
Texas	<input type="checkbox"/>	<input type="checkbox"/>

### NINTH CALL AREA

	W	C
Illinois	<input type="checkbox"/>	<input type="checkbox"/>
Indiana	<input type="checkbox"/>	<input type="checkbox"/>
Wisconsin	<input type="checkbox"/>	<input type="checkbox"/>

### SECOND CALL AREA

	W	C
New Jersey	<input type="checkbox"/>	<input type="checkbox"/>
New York	<input type="checkbox"/>	<input type="checkbox"/>

### SIXTH CALL AREA

	W	C
California	<input type="checkbox"/>	<input type="checkbox"/>

### TENTH CALL AREA

	W	C
Colorado	<input type="checkbox"/>	<input type="checkbox"/>
Iowa	<input type="checkbox"/>	<input type="checkbox"/>
Kansas	<input type="checkbox"/>	<input type="checkbox"/>
Minnesota	<input type="checkbox"/>	<input type="checkbox"/>
Missouri	<input type="checkbox"/>	<input type="checkbox"/>
Nebraska	<input type="checkbox"/>	<input type="checkbox"/>
North Dakota	<input type="checkbox"/>	<input type="checkbox"/>
South Dakota	<input type="checkbox"/>	<input type="checkbox"/>

### THIRD CALL AREA

	W	C
Delaware	<input type="checkbox"/>	<input type="checkbox"/>
Maryland — D.C.	<input type="checkbox"/>	<input type="checkbox"/>
Pennsylvania	<input type="checkbox"/>	<input type="checkbox"/>

### SEVENTH CALL AREA

	W	C
Arizona	<input type="checkbox"/>	<input type="checkbox"/>
Idaho	<input type="checkbox"/>	<input type="checkbox"/>
Montana	<input type="checkbox"/>	<input type="checkbox"/>
Nevada	<input type="checkbox"/>	<input type="checkbox"/>
Oregon	<input type="checkbox"/>	<input type="checkbox"/>
Utah	<input type="checkbox"/>	<input type="checkbox"/>
Washington	<input type="checkbox"/>	<input type="checkbox"/>
Wyoming	<input type="checkbox"/>	<input type="checkbox"/>

### OTHER

	W	C
Alaska	<input type="checkbox"/>	<input type="checkbox"/>
Hawaii	<input type="checkbox"/>	<input type="checkbox"/>

### FOURTH CALL AREA

	W	C
Alabama	<input type="checkbox"/>	<input type="checkbox"/>
Florida	<input type="checkbox"/>	<input type="checkbox"/>
Georgia	<input type="checkbox"/>	<input type="checkbox"/>
Kentucky	<input type="checkbox"/>	<input type="checkbox"/>
North Carolina	<input type="checkbox"/>	<input type="checkbox"/>
South Carolina	<input type="checkbox"/>	<input type="checkbox"/>
Tennessee	<input type="checkbox"/>	<input type="checkbox"/>
Virginia	<input type="checkbox"/>	<input type="checkbox"/>

### EIGHTH CALL AREA

	W	C
Michigan	<input type="checkbox"/>	<input type="checkbox"/>
Ohio	<input type="checkbox"/>	<input type="checkbox"/>
West Virginia	<input type="checkbox"/>	<input type="checkbox"/>

# OPEN THIS PACKAGE FIRST!

**HEATHKIT**  
CONTINUING  
EDUCATION

## HOW TO ASSEMBLE AND USE YOUR INDIVIDUAL LEARNING PROGRAM

**Model ER-3701**

**595-2008-01**

Before you begin to use this Individual Learning Program you will need to assemble and organize it. The printed material, looseleaf binder, and audio cassettes have been packed to provide maximum protection during shipping. By assembling this material yourself, you will check to see that nothing is missing. At the same time, it will give you an opportunity to look over the program and become familiar with it.

Follow the step-by-step instructions below to assemble your program. Check off each step as you complete it. Then begin the program as indicated in the last step.

1. Be sure that you have received all of the materials. Your Individual Learning Program contains:
  - ( ☒ ) One package of printed material wrapped in plastic.
  - ( ☒ ) One looseleaf binder.
  - ( ☒ ) One envelope containing charts.
  - ( ☒ ) One envelope containing the final examination. **Do not open this envelope until you are directed to.**
  - ( ☒ ) One cassette holder containing two cassettes.
  - ( ☒ ) One envelope containing miscellaneous materials.
  - ( ☐ ) One set of tab dividers.

2. Put the printed material and the tab dividers into the looseleaf binder. The printed material has already been collated in the proper sequence, but you will have to separate it and place it after the appropriate tab divider. Colored sheets have been placed between the different sections to help you separate them quickly, and there is a tab divider for each section. Place all of the introductory material in front of the tab divider for unit one.
3. Place the cassette holder in the front of the binder so the cassette tapes face the front cover.
4. Set the "Final Examination" envelope aside until it is called for. Do not open this envelope until you are directed to.
5. Begin your program. Start by playing Cassette 1, Side A. Then read the following Introduction.

# INTRODUCTION

## WHAT IS AMATEUR RADIO ALL ABOUT?

Imagine talking to people all over the world from your own home. That's what thousands of amateur radio, or "ham," operators do every day. You have already taken the first step in joining more than 500,000 other people in the world in a fascinating new hobby.

Amateur radio is many things to different people. In general, amateur radio is made up of people who want to use radio communication for pleasure, as a hobby, or for technical advancement.

Anyone can become a ham regardless of age, sex, or occupation. In fact, the Rules and Regulations were recently changed so you don't even have to be a citizen of the United States to be licensed here. During your first few on-the-air contacts with other amateurs, you may talk to a student, a well-known politician, a famous radio or television personality, or even the king of some far-away country.

### Operating Variety

Amateur radio has something to offer for just about everyone. Some operators prefer to "work" (communicate with) as many different countries as they can while others prefer to just chit-chat (called "ragchewing") with someone who has similar interests.

All amateurs fall into two main groups; the CW (Morse code) operators and the phone (voice) operators. These two groups are further broken down into smaller groups made up of contest operators, award hunters, network and phone patch operators, satellite operators, and DX operators.

The first of these sub-groups (contest operators) is made up of amateurs who are interested in challenge. Throughout each year, there are several contests sponsored that improve an amateur's operating skill. These contests usually center around working as many other stations as possible.

Some amateurs, called network operators, transmit messages between their stations similar to the way telegrams are sent. Other amateurs, phone-patch operators, interconnect their stations with the telephone lines so a non-amateur friend can talk, via radio, to a friend or relative many miles away without leaving their homes.



**Figure 1**  
**QSL Card Display**

Amateur radio operators even have their own satellites in orbit around the earth. These satellites provide communications over long distances with simple equipment. Currently, there are two of these amateur satellites in orbit which are called Oscar 6 and Oscar 7. Oscar is actually an abbreviation for "Orbiting Satellite Carrying Amateur Radio."

DX operators (DX means distant or distance) are mainly concerned with talking to amateurs in other countries all over the world. At present, amateurs in the United States have the privilege of talking to any other country in the world.

Two more sub-groups that don't fit the above groups are made up of RTTY (radioteletype) and amateur TV operators. RTTY is essentially a typewriter connected to a transmitter and receiver. When you press a key on the typewriter, a dot-dash type character is formed and is sent through your transmitter. When your receiver is tuned to an RTTY signal, the typewriter will type out whatever is being received. Some amateurs are even able to transmit pictures using RTTY (see Figure 2).

Another popular method of transmitting pictures is through slow-scan television (SSTV). This method requires a special type of camera and monitor that has a very slow (one picture takes eight seconds) scanning rate, as compared to ordinary television. Figure 3 shows a typical slow-scan television picture. In the past few years, several amateurs have been experimenting with color SSTV.



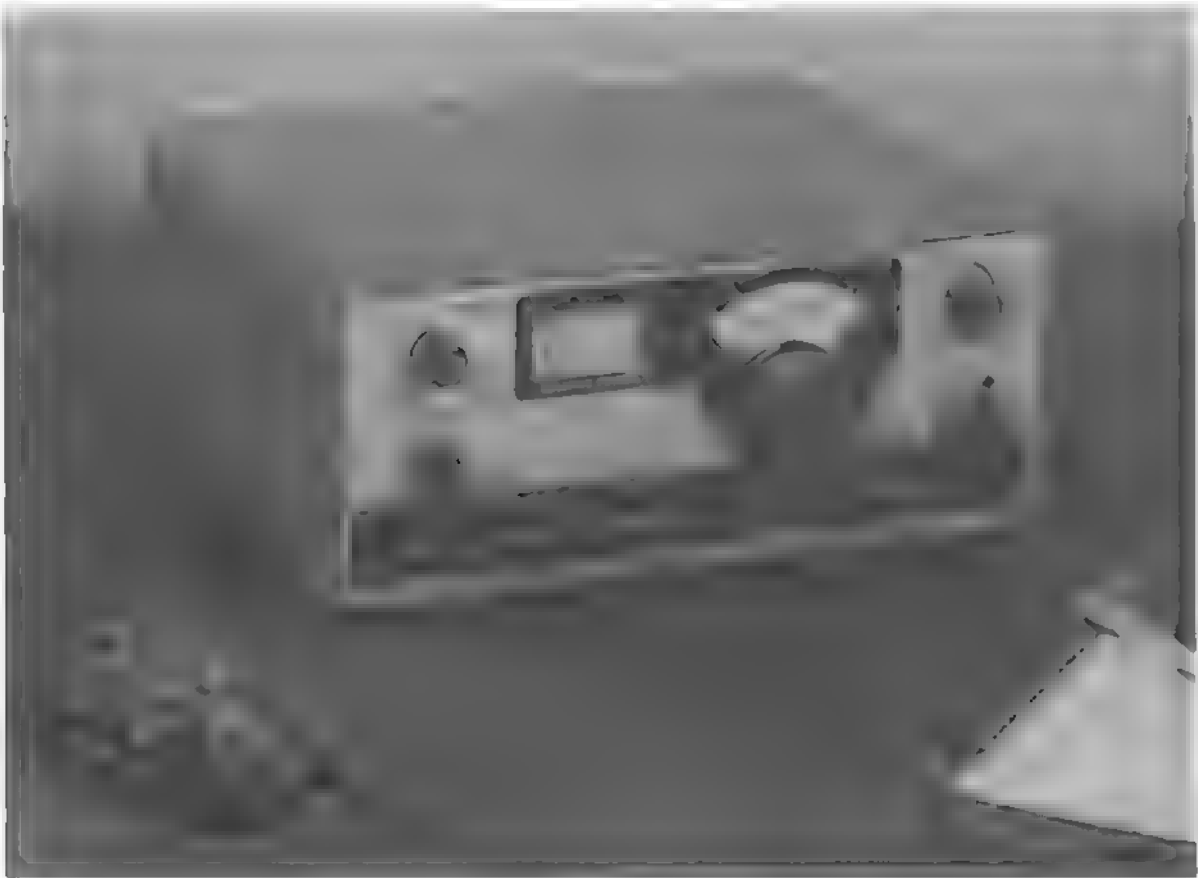
**Figure 2**  
**RTTY Picture**  
 American Bicentennial  
 1776—1976  
 200 years of freedom  
 Created by Dick Peters  
 WA1PWF, Norfolk, Mass.



**Figure 3**  
**SSTV Picture**

### Station Variety

Amateur stations vary almost as much as operator preference. You can find amateur stations almost anywhere in a home, office, car, boat, airplane, or even on a bicycle. Some amateurs install a simple station in a spare corner of a room while others may have elaborate stations taking up a whole room. Figure 4 shows a simple station that a beginner may use. Figure 5 shows an elaborate station that an experienced operator may own.



**Figure 4**  
**Simple Station**



The antenna connected to your station may be anything from a simple long-wire antenna, hung between two trees, to a multielement rotary antenna on a tall tower. The last section of this Course gives detailed instructions so you can construct your own, simple, inexpensive antenna that is suitable for a beginner's station.



**Figure 5**  
**Elaborate Station**

## HOW TO USE THIS COURSE

The purpose of this Course is to teach you only what you need to know to pass the Novice examination. Electronics theory has been kept at a minimum.

A relatively new learning technique called "programmed instruction" is used throughout this Course. Programmed instruction has proven itself as an easy learning method that helps you retain what you learn. Each section, called a "module," is designed so you can skip over any areas that you already know.

Skim through Module 1 and note how it is organized. The first thing you find is a list of objectives that specifically tells you what you will learn. Next is a pretest. How well you do on this test will determine if you need to study this module or skip over it and go on to Module 2. Following the pretest is a short introduction that gives an overview of the information that is presented in the module. Next is the actual programmed instruction for this module.

The programmed instruction section of each module is broken down into numbered blocks called "frames." Some frames contain new information and have the important items in **bold** type. Other frames simply ask a question or review previous information. Most frames require you to answer a question. Many require you to fill in a blank, while others may ask you to choose a correct answer from a list, match two columns, or draw something. Immediately below each frame, in the shaded area, is the answer to the question asked in the frame. As you read each frame, cover the shaded area below the frame with a piece of paper. Answer the question in the frame as well as you can; then check the answer in the shaded area. If you answer a question incorrectly, go back and reread the frame to find out why your answer is wrong before you proceed to the next frame. NOTE: If you are asked to fill in a blank and you write in a word that has the same meaning as the answer given, your answer is acceptable.

At the end of each module is a multiple choice examination that will check your understanding and retention of the material in the module. Follow the instructions at the beginning of the examination.

After Module 9, there are two practice examinations which contain questions from each of the nine modules. Follow the instructions supplied with these examinations. Then proceed to the "Final Examination."

# INDIVIDUAL LEARNING PROGRAM IN AMATEUR RADIO

**ER-3701**



## COURSE OBJECTIVES

When you have completed this Course, you will be able to do the following:

1. Accurately send and receive the Morse code at the rate of five words per minute (25 letters per minute).
2. Pass a 20-question, multiple-choice test from the Federal Communications Commission that deals with the following subjects:
  - A. Rules and Regulations.
  - B. Radio Phenomena.
  - C. Operating Procedures.
  - D. Emission Characteristics.
  - E. Electrical Principles.
  - F. Circuit Components.
  - G. Practical Circuits.
  - H. Antennas and Transmission Lines.
  - I. Radio Communication Practices.







## MONEY BACK GUARANTEE

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# RULES AND REGULATIONS

## Part 97 | *Amateur Radio Service*

MARCH 1, 1977

### FEDERAL COMMUNICATIONS COMMISSION





This copy of Part 97 of the Commission's Rules and Regulations governing AMATEUR RADIO SERVICE is current as of March 1, 1977.

The Commission will issue revised editions annually or as required. In the interim, all rule amendments will be published in the Federal Register.

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AUTHORITY: §§ 97.1 to 97.313 issued under 48 Stat. 1066, 1082, as amended; 47 U.S.C. 154, 303. Interpret or apply 48 Stat. 1064-1068, 1081-1105, as amended; 47 U.S.C. Sub-chap. I, III-VI.

## RULES AND REGULATIONS

### SUBPART A—GENERAL

#### § 97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary non-commercial communication service, particularly with respect to providing emergency communications.

(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

#### § 97.3 Definitions.

(a) *Amateur radio service.* A radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.

(b) *Amateur radio communication.* Noncommercial radio communication by or among amateur radio stations solely with a personal aim and without pecuniary or business interest.

(c) *Amateur radio operator.* A person interested in radio technique solely with a personal aim and without pecuniary interest, holding a valid Federal Communications Commission license to operate amateur radio stations.

(d) *Amateur radio license.* The instrument of authorization issued by the Federal Communications Commission comprised of a station license, and in the case of the primary station, also incorporating an operator license.

*Operator license.* The instrument of authorization including the class of operator privileges.

*Interim Amateur Permit.* A temporary operator and station authorization issued to licensees successfully completing Commission supervised examinations for higher class operator licenses.

*Station license.* The instrument of authorization for a radio station in the Amateur Radio Service.

(e) *Amateur radio station.* A station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communication.

(f) *Primary station.* The principal amateur radio station at a specific land location shown on the station license.

(g) *Military recreation station.* An amateur radio station licensed to the person in charge of a station at a land location provided for the recreational use of amateur radio operators, under military auspices of the Armed Forces of the United States.

(h) *Club station.* A separate Amateur radio station licensed to an Amateur radio operator acting as a station trustee for a *bona fide* amateur radio organization or society. A *bona fide* Amateur radio organization or society shall be composed of at least two persons, one of whom must be a licensed Amateur operator, and shall have:

- (1) A name,
- (2) An instrument of organization (e.g., constitution),
- (3) Management, and
- (4) A primary purpose which is devoted to Amateur radio activities consistent with § 97.1 and constituting the major portion of the club's activities.

(i) *Additional station.* Any amateur radio station licensed to an amateur radio operator normally for a specific land location other than the primary station, which may be one or more of the following:

*Secondary station.* Station licensed for a land location other than the primary location, i.e., for use at a subordinate location such as an office, vacation home, etc.

*Control station.* Station licensed to conduct remote control of another amateur radio station.

*Auxiliary link station.* Station, other than a repeater station, at a specific land location licensed only for the purpose of automatically relaying radio signals from that location to another specific land location.

*Repeater station.* Station licensed to retransmit automatically the radio signals of other amateur radio stations.

*Special Event Station.* Station licensed at a specific land location for operation related to the celebration of an event, past or present, which is unique, distinct, and of general interest to either the public or to amateur radio operators, for the purpose of bringing public notice to the Amateur Radio Service.

(j) *Space radio station.* An amateur radio station located on an object which is beyond, is intended to go beyond, or has been beyond the major portion of the earth's atmosphere. (Regulations governing this type of station have not yet been adopted and all applications will be considered on an individual basis.)

(k) *Terrestrial location.* Any point within the major portion of the earth's atmosphere, including aeronautical, land, and maritime locations.

(l) *Space location.* [Reserved]

(m) *Amateur radio operation.* Amateur radio communication conducted by an amateur radio operator from an amateur radio station. May include one or more of the following.

*Fixed operation.* Radio communication conducted from the specific geographical land location shown on the station license.

*Portable operation.* Radio communication conducted from a specific geographical location other than that shown on the station license.

*Mobile operation.* Radio communication conducted while in motion or during halts at unspecified locations.

(n) *Control.* Techniques for accomplishing the prerequisite responsibilities for the immediate operation

of an amateur radio station. Must be one or more of the following:

(1) *Local control.* Manual control, with the control operator monitoring the operation on duty at the control point located at a station transmitter with the associated operating adjustments directly accessible. (Direct mechanical control, or direct wire control of a transmitter from a control point located on board any aircraft, vessel, or on the same premises on which the transmitter is located, is also considered local control.)

(2) *Remote control.* Manual control, with the control operator monitoring the operation on duty at a control point located elsewhere than at the station transmitter, such that the associated operating adjustments are accessible through a control link.

(3) *Automatic control.* The use of devices and procedures for control so that a control operator does not have to be present at the control point at all times. (Only rules for automatic control of repeater systems have been adopted. Automatic control of all other types of amateur radio stations must be approved by the Commission on a case-by-case basis.)

(o) *Control link.* Apparatus for effecting remote control between a control point and a remotely controlled station.

(p) *Control operator.* An amateur radio operator designated by the licensee of an amateur radio station to also be responsible for the emissions from that station.

(q) *Control point.* The operating position of an amateur radio station where the control operator function is performed

(r) *Antenna structures.* Antenna structures include the radiating system, its supporting structures, and any appurtenances mounted thereon.

(s) *Antenna height above average terrain.* The height of the center of radiation of an antenna above an averaged value of the elevation above sea level for the surrounding terrain.

(t) *Transmitter.* Apparatus for converting electrical energy received from a source into radio-frequency electromagnetic energy capable of being radiated.

(u) *Effective radiated power.* The product of the radio-frequency power, expressed in watts, delivered to an antenna, and the relative gain of the antenna over that of a half-wave dipole antenna.

(v) *System network diagram.* A diagram showing each station and its relationship to the other stations in a network of stations, and to the control point(s).

(w) *Third-party traffic.* Amateur radio communication by or under the supervision of the control operator at an amateur radio station to another amateur radio station on behalf of anyone other than the control operator.

(x) *Emergency communication.* Any amateur radio communication directly relating to the immediate safety of life of individuals or the immediate protection of property.

(y) *Automatic retransmission.* Retransmission of signals by an amateur radio station whereby the retransmitting station is actuated solely by the presence of a

received signal through electrical or electro-mechanical means, i.e., without any direct, positive action by the control operator.

## SUBPART B—AMATEUR OPERATOR AND STATION LICENSES

### OPERATOR LICENSES

#### § 97.5 Classes of operator licenses.

Amateur extra class.

Advanced class (previously class A).

General class (previously class B)

Conditional class (previously class C).

Technician class.

Novice class.

#### § 97.7 Privileges of operator licenses.

(a) *Amateur Extra Class and Advanced Class.* All authorized amateur privileges including exclusive frequency operating authority in accordance with the following table:

Frequencies	Class of license authorized
3500-3525 kHz	Amateur Extra Only
3775-3800 kHz	
7000-7025 kHz	
14,000-14,025 kHz	
21,000-21,025 kHz	
21,250-21,270 kHz	
3800-3890 kHz	Amateur Extra and Advanced.
7150-7225 kHz	
14,200-14,275 kHz	
21,270-21,350 kHz	
50-50.1 MHz	

(b) *General Class.* All authorized amateur privileges except those exclusive operating privileges which are reserved to the Advanced Class and/or Amateur Extra Class.

(c) *Conditional Class.* Same privileges as General Class. New Conditional Class licenses will not be issued. Present Conditional Class licensees will be issued General Class licenses at time of renewal or modification.

(d) *Technician Class.* All authorized amateur privileges on the frequencies 50.1-54 MHz and 145-148 MHz and in the Amateur bands above 220 MHz. Such licenses also carry the full privileges of the Novice Class license.

(e) *Novice Class.* Radiotelegraphy in the frequency bands 3700-3750 kHz, 7100-7150 kHz (7050-7075 kHz when the terrestrial station location is not within Region 2), 21,100-21,200 kHz, and 28,100-28,200 kHz, using only Type A1 emission.

#### § 97.9 Eligibility for new operator license.

Anyone except a representative of a foreign government is eligible for an amateur operator license.

#### § 97.11 Application for operator license.

(a) An application (FCC Form 610) for a new opera-

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tor license, including an application for change in operating privileges, which will require an examination supervised by Commission personnel at a regular Commission examining office shall be submitted to such office in advance of or at the time of the examination, except that, whenever an examination is to be taken at a designated examination point away from a Commission office, the application, together with the necessary filing fee should be submitted in advance of the examination date to the office which has jurisdiction over the examination point involved.

(b) An application (FCC Form 610) for a new operator license, including an application for change in operating privileges, which requests an examination supervised by a volunteer examiner under the provisions of § 97.27, shall be submitted to the FCC field office nearest the applicant. Applications for the Novice Class license should be sent to the Commission's offices in Gettysburg, Pa. 17325. All applications should be accompanied by any necessary filing fee.

(c) An application (FCC Form 610) for renewal and/or modification of license when no change in operating privileges is involved shall be submitted, together with any necessary filing fee, to the Commission's office at Gettysburg, Pennsylvania, 17325.

### § 97.13 Renewal or modification of operator license.

(a) An Amateur operator license, except the Novice Class, may be renewed upon proper application.

(b) The Novice Class license will not be renewed.

(c) The applicant shall qualify for a new license by examination if the requirements of this section are not fulfilled.

(d) Application for renewal and/or modification of an amateur operator license shall be submitted on FCC Form 610 and shall be accompanied by the applicant's license. Application for renewal of unexpired licenses must be made during the license term and should be filed within 90 days but not later than 30 days prior to the end of the license term. In any case in which the licensee has, in accordance with the provisions of this chapter, made timely and sufficient application for renewal of an unexpired license, no license with reference to any activity of a continuing nature shall expire until such application shall have been finally determined.

(e) If a license is allowed to expire, application for renewal may be made during a period of grace of one year after the expiration date. During this one year period of grace, an expired license is not valid. A license renewed during the grace period will be dated currently and will not be backdated to the date of its expiration. Application for renewal shall be submitted on FCC Form 610 and shall be accompanied by the applicant's expired license.

(f) When the name of a licensee is changed or when the mailing address is changed a formal application for modification of license is not required. However, the licensee shall notify the Commission promptly of these changes. The notice, which may be in letter form, shall contain the name and address of the licen-

see as they appear in the Commission's records, the new name and/or address, as the case may be, the radio station call sign and class of operator license. The notice shall be sent to Federal Communications Commission, Gettysburg, Pa. 17325 and a copy shall be kept by the licensee until a new license is issued.

## OPERATOR LICENSE EXAMINATIONS

### § 97.19 When examination is required.

Examination is required for the issuance of a new amateur operator license, and for a change in class of operating privileges. Credit may be given, however, for certain elements of examination as provided in § 97.25.

### § 97.21 Examination elements.

Examinations for amateur operator privileges will comprise one or more of the following examination elements:

(a) Element 1(A): Beginner's code test at five (5) words per minute;

(b) Element 1(B): General code test at thirteen (13) words per minute;

(c) Element 1(C): Expert's code test at twenty (20) words per minute,

(d) Element 2: Basic law comprising rules and regulations essential to beginners' operation, including sufficient elementary radio theory for the understanding of those rules;

(e) Element 3: General amateur practice and regulations involving radio operation and apparatus and provisions of treaties, statutes, and rules affecting amateur stations and operators;

(f) Element 4(A): Intermediate amateur practice involving intermediate level radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony and radiotelegraphy;

(g) Element 4(B): Advanced amateur practice involving advanced radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony, radiotelegraphy, and transmissions of energy for measurements and observations applied to propagation, for the radio control of remote objects and for similar experimental purposes.

### § 97.23 Examination requirements.

Applicants for operator licenses will be required to pass the following examination elements:

(a) Amateur Extra Class: Elements 1(C), 2, 3, 4(A) and 4(B);

(b) Advanced Class: Elements 1(B), 2, 3, and 4(A);

(c) General Class: Elements 1(B), 2 and 3;

(d) Technician Class: Elements 1(A), 2, and 3;

(e) Novice Class: Elements 1(A) and 2.

### § 97.25 Examination credit.

(a) An applicant for a higher class of amateur operator license who holds any valid amateur license will be required to pass only those elements of the higher class examination that are not included in the examination for the amateur license held.

(b) An applicant for an amateur operator license will be given credit for either telegraph code element 1(A) or 1(B) if within 5 years prior to the receipt of his application by the Commission he held a commercial radiotelegraph operator license or permit issued by the Federal Communications Commission. An applicant for an amateur extra class license will be given credit for the telegraph code element 1(C) if he holds a valid first class commercial radiotelegraph operator license or permit issued by the Federal Communications Commission or holds any commercial radiotelegraph operator license or permit issued by the Federal Communications Commission containing an aircraft radiotelegraph endorsement.

(c) An applicant for the Amateur Extra Class operator license will be given credit for examination elements 1(C), 4(A), and 4(B), if he so requests and submits evidence of having held a valid amateur radio station or operator license issued by any agency of the U.S. Government during or prior to April 1917, and qualifies for or currently holds a valid amateur operator license of the General or Advanced Class.

(d) An applicant for the amateur extra class operator license will be given credit for examination element 1(C) if he so requests and submits evidence of having held the amateur extra first class license, having continuously held its successor license. An applicant should present his proof in advance of the desired examination time to the Chief, Personal Radio Division, Washington, D.C. 20554 and receive a letter of certification for presentation to the field office where the examination will be taken. No code credit will be given without the letter of certification.

(e) No examination credit, except as herein provided, shall be allowed on the basis of holding or having held any amateur or commercial operator license.

#### **§ 97.27 Mail examinations for applicants unable to travel.**

The Commission may permit the examinations for an Amateur Extra, Advanced, General, or Technician Class license to be administered at a location other than a Commission examination point by an examiner chosen by the Commission when it is shown by physician's certification that the applicant is unable to appear at a regular Commission examination point because of a protracted disability preventing travel.

#### **§ 97.28 Manner of conducting examinations.**

(a) Except as provided in § 97.27, all examinations for Amateur Extra, Advanced, General, and Technician Class operator licenses will be conducted by authorized Commission personnel or representatives at locations and times specified by the Commission. Examination elements given under the provisions of § 97.27 will be administered by an examiner selected by the Commission. All applications for consideration of eligibility under § 97.27 should be filed on FCC Form 610, and should be sent to the FCC field office nearest the applicant. (A list of these offices appears in § 0.121 of the Commission's Rules and can be obtained from the

Regional Services Division, Field Operations Bureau, FCC, Washington, D.C. 20554, or any field office.)

(b) Unless otherwise prescribed by the Commission, examinations for the Novice Class license will be conducted and supervised by a volunteer examiner selected by the applicant. The volunteer examiner shall be at least 21 years of age, shall be unrelated to the applicant, and shall be the holder of an Amateur Extra, Advanced, or General Class operator license. The written portion of the Novice examination, Element 2, shall be obtained, administered, and submitted in accordance with the following procedure:

(1) Within 10 days after successfully completing telegraphy examination element 1(A), an applicant shall submit an application (FCC Form 610) to the Commission's office in Gettysburg, Pennsylvania 17325. The application shall include a written request from the volunteer examiner for the examination papers for Element 2. The examiner's written request shall include (i) the names and permanent addresses of the examiner and the applicant, (ii) a description of the examiner's qualifications to administer the examination, (iii) the examiner's statement that the applicant has passed telegraphy element 1(A) under his supervision within the 10 days prior to submission of the request, and (iv) the examiner's written signature. Examination papers will be forwarded only to the volunteer examiner.

(2) The volunteer examiner shall be responsible for the proper conduct and necessary supervision of the examination. Administration of the examination shall be in accordance with the instructions included with the examination papers.

(3) The examination papers, either completed or unopened in the event the examination is not taken, shall be returned by the volunteer examiner to the Commission's office in Gettysburg, Pa., no later than 30 days after the date the papers are mailed by the Commission (the date of mailing is normally stamped by the Commission on the outside of the examination envelope).

(c) The code test required of an applicant for an amateur radio operator license, in accordance with the provisions of §§ 97.21 and 97.23 shall determine the applicant's ability to transmit by hand key (straight key or, if supplied by the applicant, any other type of hand operated key such as a semi-automatic or electronic key, but not a keyboard keyer) and to receive by ear, in plain language, messages in the international Morse code at not less than the prescribed speed during a five minute test period. Each five characters shall be counted as one word. Each punctuation mark and numeral shall be counted as two characters.

(d) All written portions of the examinations for amateur operator privileges shall be completed by the applicant in legible handwriting or hand printing. Whenever the applicant's signature is required, his normal signature shall be used. Applicants unable to comply with these requirements, because of physical disability, may dictate their answers to the examination questions and the receiving code test. If the

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examination or any part thereof is dictated, the examiner shall certify the nature of the applicant's disability and the name and address of the person(s) taking and transcribing the applicant's dictation.

### § 97.31 Grading of examinations.

(a) Code tests for sending and receiving are graded separately.

(b) Seventy-four percent (74%) is the passing grade for written examinations. For the purpose of grading, each element required in qualifying for a particular license will be considered as a separate examination. All written examinations will be graded only by Commission personnel.

### § 97.32 Interim Amateur Permits.

(a) Upon successful completion of a Commission supervised Amateur Radio Service operator examination, an applicant already licensed in the Amateur Radio Service may operate his amateur radio station pending issuance of his permanent amateur operator and station licenses under the terms and conditions of an Interim Amateur Permit, evidenced by a properly executed FCC Form 660-B.

(b) An Interim Amateur Permit conveys all operating privileges of the applicant's new operator license classification.

(c) The transmissions of amateur radio stations operated under the authority of Interim Amateur Permits shall be identified in the manner specified in § 97.87.

(d) The original Interim Amateur Permit of an amateur radio operator shall be kept in the personal possession of or posted in a conspicuous place in the room occupied by such operator when operating an amateur radio station under the authority of an Interim Amateur Permit.

(e) Interim Amateur Permits are valid for a period of 90 days from the date of issuance or until issuance of the permanent station and operator licenses, whichever comes first, but may be set aside by the Commission within the 90 day term if it appears that the permanent operator and station licenses cannot be granted routinely.

(f) Interim Amateur Permits shall not be renewed.

### § 97.33 Eligibility for re-examination.

An applicant who fails a written examination for an amateur radio operator license may not take another written examination for the same or higher class license within 30 days.

## STATION LICENSES

### § 97.37 General eligibility for station license.

An amateur radio station license will be issued only to a licensed amateur radio operator, except that a military recreation station license may also be issued to an individual not licensed as an amateur radio operator (other than a representative of a foreign government), who is in charge of a proposed military

recreation station not operated by the U.S. Government but which is to be located in approved public quarters.

### § 97.39 Eligibility of corporations or organizations to hold station license.

An amateur station license will not be issued to a school, company, corporation, association, or other organization, except that in the case of a *bona fide* amateur radio organization or society meeting the criteria set forth in Section 97.3, a station license may be issued to a licensed amateur operator, other than the holder of a Novice Class license, as trustee for such society.

### § 97.40 Station license required.

(a) No transmitting station shall be operated in the amateur radio service without being licensed by the Federal Communications Commission.

(b) Every amateur radio operator must have a primary amateur radio station license.

(c) An amateur radio operator may be issued one or more additional station licenses, each for a different land location, except that repeater station, control station, auxiliary link station, and special event station licenses may be issued to an amateur radio operator for land locations where another station license had been issued to the applicant.

(d) Any transmitter to be operated as part of a control link shall be licensed as a control station or as an auxiliary link station and may be combined with a primary, secondary, or club station license at the same location.

(e) A transmitter may only be operated as a repeater station under the authority of a repeater station license.

### § 97.41 Application for station license.

(a) Each application for a club or military recreation station license in the Amateur Radio Service shall be made on the FCC Form 610-B. Each application for any other amateur radio license, except a special event station, shall be made on the FCC Form 610.

(b) Each application shall state whether the proposed station is a primary or additional station. If the latter, the application shall also state whether the proposed station is a secondary, control, auxiliary link, or repeater station.

(c) Each application to license a remotely controlled amateur radio station shall be accompanied by a statement so indicating.

(d) An application by letter to the Personal Radio Division, Federal Communications Commission, Washington, D.C. 20554, may be made by an Advanced Class or Amateur Extra Class licensee for a license to operate one special event station for the period of the celebration, but not to exceed 30 days unless extraordinary circumstances are shown. The application shall contain the following:

(1) The name, mailing address, photocopy of amateur operator license, and signature of applicant.



(2) The name and description of the celebration, its significance to the public or to amateur radio operators, and the justification for the proposed special event station.

(3) The location of the proposed station.

(4) The dates the station will be operated, and justification.

(5) Specific call sign requested, if desired.

(e) One application and all papers incorporated therein and made a part thereof shall be submitted for each amateur station license. If the application is only for a station license, other than a special event station, it shall be filed directly with the Commission at its Gettysburg, Pennsylvania office. If the application also contains application for any class of amateur operator license, it shall be filed in accordance with the provisions of § 97.11.

(f) Applicants proposing to construct a radio station on a site located on land under the jurisdiction of the U.S. Forest Service, U.S. Department of Agriculture, or the Bureau of Land Management, U.S. Department of the Interior, must supply the information and must follow the procedures prescribed by § 170 of this chapter.

(g) Each applicant in the Safety and Special Radio Services (1) for modification of a station license involving a site change or a substantial increase in tower height or (2) for a license for a new station must, before commencing construction, supply the environmental information, where required, and must follow the procedure prescribed by Subpart I of Part 1 of this chapter (§§ 1.1301 through 1.1319) unless Commission action authorizing such construction would be a minor action with the meaning of Subpart I of Part 1.

#### § 97.42 Mailing address furnished by licensee.

Except for applications submitted by Canadian citizens pursuant to agreement between the United States and Canada (TIAS No. 2508 and No. 6931), each application shall set forth and each licensee shall furnish the Commission with an address in the United States to be used by the Commission in serving documents or directing correspondence to that licensee. Unless any licensee advises the Commission to the contrary, the address contained in the licensee's most recent application will be used by the Commission for this purpose.

#### § 97.43 Location of station.

Every amateur station must have one land location, the address of which is designated on the station license. Every amateur radio station must have at least one control point. If the control point location is not the same as the station location, authority to operate the station by remote control is required.

#### § 97.45 Limitations on antenna structures.

(a) Except as provided in paragraph (b) of this section, an antenna for a station in the Amateur Radio

Service which exceeds the following height limitations may not be erected or used unless notice has been filed with both the FAA on FAA Form 7460-1 and with the Commission on Form 714 or on the license application form, and prior approval by the Commission has been obtained for:

(1) Any construction or alteration of more than 200 feet in height above ground level at its site (§ 17.7 (a) of this chapter).

(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes (§ 17.7(b) of this chapter):

(i) 100 to 1 for a horizontal distance of 20,000 feet from the nearest point of the nearest runway of each airport with at least one runway more than 3,200 feet in length, excluding heliports and seaplane bases without specified boundaries, if that airport is either listed in the Airport Directory of the current Airman's Information Manual or is operated by a Federal military agency.

(ii) 50 to 1 for a horizontal distance of 10,000 feet from the nearest point of the nearest runway of each airport with its longest runway no more than 3,200 feet in length, excluding heliports and seaplane bases without specified boundaries, if that airport is either listed in the Airport Directory or is operated by a Federal military agency.

(iii) 25 to 1 for a horizontal distance of 5,000 feet from the nearest point of the nearest landing and takeoff area of each heliport listed in the Airport Directory or operated by a Federal military agency.

(3) Any construction or alteration on an airport listed in the Airport Directory of the Airman's Information Manual (§ 17.7(c) of this chapter).

(b) A notification to the Federal Aviation Administration is not required for any of the following construction or alteration:

(1) Any object that would be shielded by existing structures of a permanent and substantial character or by natural terrain or topographic features of equal or greater height, and would be located in the congested area of a city, town, or settlement where it is evident beyond all reasonable doubt that the structure so shielded will not adversely affect safety in air navigation. Applicants claiming such exemption shall submit a statement with their application to the Commission explaining the basis in detail for their finding (§ 17.14 (a) of this chapter).

(2) Any antenna structure of 20 feet or less in height except one that would increase the height of another antenna structure (§ 17.14(b) of this chapter).

(c) Further details as to whether an aeronautical study and/or obstruction marking and lighting may be required, and specifications for obstruction marking and lighting when required, may be obtained from Part 17 of this chapter, "Construction, Marking, and Lighting of Antenna Structures." Information regarding the inspection and maintenance of antenna structures requiring obstruction marking and lighting is also contained in Part 17 of this chapter.

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### § 97.47 Renewal and/or modification of amateur station license.

(a) Application for renewal and/or modification of an individual station license shall be submitted on FCC Form 610, and application for renewal and/or modification of an amateur club or military recreation station shall be submitted on FCC Form 610-B. In every case the application shall be accompanied by the applicant's license or photocopy thereof. Applications for renewal of unexpired licenses must be made during the license term and should be filed not later than 60 days prior to the end of the license term. In any case in which the licensee has in accordance with the provisions of this chapter, made timely and sufficient application for renewal of an unexpired license, no license with reference to any activity of a continuing nature shall expire until such application shall have been finally determined.

(b) If a license is allowed to expire, application for renewal may be made during a period of grace of 1 year after the expiration date. During this 1-year period of grace, an expired license is not valid. A license renewed during the grace period will be dated currently and will not be backdated to the date of expiration. An application for an individual station license shall be submitted on FCC Form 610. An application for an amateur club or military recreation station license shall be submitted on FCC Form 610-B. In every case the application shall be accompanied by the applicant's expired license or a photocopy thereof.

(c) When the name of a licensee is changed (without changes in the ownership, control, or corporate structure), or when the mailing address is changed (without changing the authorized location of the amateur radio station) a formal application for modification of license is not required. However, the licensee shall notify the Commission promptly of these changes. The notice, which may be in letter form, shall contain the name and address of the licensee as they appear in the Commission's records, the new name and/or address, as the case may be, and the call sign and the class of operator license. The notice shall be sent to Federal Communications Commission, Gettysburg, Pa., 17325, and a copy shall be maintained with the license of each station until a new license is issued.

### § 97.49 Commission modification of station license.

(a) Whenever the Commission shall determine that public interest, convenience, and necessity would be served, or any treaty ratified by the United States will be more fully complied with, by the modification of any radio station license either for a limited time, or for the duration of the term thereof, it shall issue an order for such licensee to show cause why such license should not be modified.

(b) Such order to show cause shall contain a statement of the grounds and reasons for such proposed modification, and shall specify wherein the said license is required to be modified. It shall require the licensee against whom it is directed to appear at a place and time therein named, in no event to be less than 30

days from the date of receipt of the order, to show cause why the proposed modification should not be made and the order of modification issued.

(c) If the licensee against whom the order to show cause is directed does not appear at the time and place provided in said order, a final order of modification shall issue forthwith.

## CALL SIGNS

### § 97.51 Assignment of call signs.

(a) The call signs of amateur stations will be assigned systematically by the Commission with the following exceptions:

(1) A specific unassigned call sign may be reassigned to a previous holder thereof.

(2) A specific unassigned call sign may be temporarily assigned to a special event station.

(3) One specific unassigned 1X2 call sign, (a call sign having one letter, then the numeral, followed by two letters), may be assigned to the station of a previous holder of a 1X2 call sign.

(4) One specific unassigned 1X2 call sign may be assigned to the station of an Amateur Extra Class licensee who previously held or presently holds a 1X2 call sign.

(5) One specific unassigned 1X2 call sign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he held any amateur radio operator or station license, issued by any agency of the U.S. Government or by any foreign government, 25 or more years prior to the receipt date of an application for such assignment.

(6) Effective October 1, 1976, one specific unassigned 1X2 call sign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to November 22, 1967.

(7) Effective January 1, 1977, one specific unassigned 1X2 call sign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to July 2, 1974.

(8) Effective April 1, 1977, one specific unassigned 1X2 call sign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to July 1, 1976.

(9) Effective July 1, 1977, one specific unassigned 1X2 call sign may be assigned to the station of any Amateur Extra Class licensee.

(10) The provisions of paragraphs (3) through (9) of this section shall also apply to the issuance of 2X2 call signs in Alaska, Hawaii, and U.S. possessions.

(b) An amateur call sign will consist of a sequence of one or two letters, a numeral designating the call sign area, and not more than three letters. The call sign areas are as follows:

No.

1. Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
2. New York, New Jersey

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3. Pennsylvania, Delaware, Maryland, District of Columbia.
4. Virginia, North and South Carolina, Georgia, Florida, Alabama, Tennessee, Kentucky, Puerto Rico and Virgin Islands.
5. Mississippi, Louisiana, Arkansas, Oklahoma, Texas, New Mexico.
6. California, Hawaii and Pacific possessions except those included in area 7.
7. Oregon, Washington, Idaho, Montana, Wyoming, Arizona, Nevada, Utah, Alaska and adjacent islands.
8. Michigan, Ohio, West Virginia.
9. Wisconsin, Illinois, Indiana.
10. Colorado, Nebraska, North and South Dakota, Kansas, Minnesota, Iowa, Missouri.

## § 97.53 Policies and procedures applicable to assignment of call signs.

(a) The following are regarded as preferred call signs:

(1) 1X2 call signs—call signs with a single letter prefix and two letter suffix, e.g. W6AB, and 2X2 call signs in Alaska, Hawaii, and U.S. possessions.

(2) 1X3 call signs—call signs with a single letter prefix and a three letter suffix, e.g. W6ABC.

(b) An eligible licensee will be permitted to hold only one 1X2 call sign. However, a licensee who, by reason of former rule provisions, presently holds more than one such call sign, may continue to hold those same call signs in the same call sign areas.

(c) In those instances where an applicant is not eligible for a specific call sign, a 1X2 call sign beginning with the letter 'W' will, subject to availability, normally be assigned to an eligible licensee.

(d) An eligible licensee who holds one or more three-letter call signs must relinquish one of those call signs in order to be assigned a two-letter call sign.

(e) New additional stations will not be assigned a preferred call sign.

(f) An additional station which is presently assigned a preferred call sign will be issued a nonpreferred call sign upon modification of license to show a station location in a different call sign area.

(g) Subject to availability, a primary station will be issued the same type of call sign as the one relinquished upon modification of license to show a station location in a different call sign area.

(h) Except as provided in § 97.51(a), licensees will not be assigned specific call signs or counterpart call signs, (call signs with identical suffix letters).

(i) Those Amateur Extra Class licensees eligible under the provisions of § 97.51(a) for a specific unassigned 1X2 call sign may specify in their applications more than one call sign in order of preference. In those instances where none of the listed call signs are available, the application will be returned without action unless the licensee has stated that he will accept, as a last choice, any unassigned 1X2 call sign.

(j) Call signs which have been unassigned for more than one year are normally available for reassignment.

## DUPLICATE LICENSES AND LICENSE TERM

### § 97.57 Duplicate license.

Any licensee requesting a duplicate license to re-

place an original which has been lost, mutilated, or destroyed, shall submit a statement setting forth the facts regarding the manner in which the original license was lost, mutilated, or destroyed. If, subsequent to receipt by the licensee of the duplicate license, the original license is found, either the duplicate or the original license shall be returned immediately to the Commission.

### § 97.59 License term.

(a) Amateur operator licenses are normally valid for a period of 5 years from the date of issuance of a new or renewed license, except the Novice Class which is normally valid for a period of 2 years from the date of issuance.

(b) The license for an amateur station is normally valid for a period of 5 years from the date of issuance of a new or renewed license, except that an amateur station license issued to the holder of a Novice Class amateur operator license is normally valid for a period of 2 years from the date of issuance. All amateur station licenses, regardless of when issued, will expire on the same date as the licensee's amateur operator license.

(c) A duplicate license or a modified license which is not being renewed shall bear the same expiration date as the license for which it is a modification or duplicate.

## SUBPART C—TECHNICAL STANDARDS

### § 97.61 Authorized frequencies and emissions.

(a) Following are the frequency bands and associated emissions available to amateur radio stations, other than repeater stations, subject to the limitations stated in paragraph (b) of this section, §§ 97.65, 97.109, and 97.110.

Frequency band	Emissions	Limitations (See paragraph (b))
kHz		
1800-2000	A1, A3	1.2
3500-4000	A1	
3500-3775	F1	
3775-3890	A5, F5	
3775-4000	A3, F3	4
4983.8	A3J, A3A	13
7000-7300	A1	3.4
7000-7150	F1	3.4
7075-7100	A3, F3	11
7160-7225	A5, F5	3.4
7150-7300	A3, F3	3.4
14090-14350	A1	
14000-14200	F1	
14200-14275	A5, F5	
14200-14350	A3, F3	
MHz		
21 000-21 450	A1	
21 800-21 250	F1	
21 250-21 350	A5, F5	
21 250-21 450	A3, F3	
28 000-29 700	A1	
28 000-28 500	F1	
28 500-29 700	A3, F3, A5, F5	
50.0-54.0	A1	
50.1-54.0	A2, A3, A4, A5, F1, F2, F3, F5	
51.0-54.0	A0	
144-148	A1	
144.1-148.0	A0, A2, A3, A4, A5, F0, F1, F2, F3, F5	
220-225	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5	5.6

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Frequency band	Emissions	Limitations (See paragraph (b))	Frequency band	Emissions	Limitations (See paragraph (b))
1215-1300	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5	5.7	Above 300.000	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P	
2300-2450	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P	5.8			
3300-3500	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P	5.12			
5650-5925	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P	5.9			
10.000-10.500	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5	5			
24.000-24.250	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P	5.10			
48.000-50.000	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P				
71.000-76.000	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P				
165.000-170.000	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P				
240.000-250.000	A0, A1, A2, A3, A4, A5, F0, F1, F2, F3, F4, F5, P				

## (b) Limitations:

(1) The use of frequencies in this band is on a shared basis with the LORAN-A radionavigation system and is subject to cancellation or revision, in whole or in part, by order of the Commission, without hearing, whenever the Commission shall determine such action is necessary in view of the priority of the LORAN-A radionavigation system. The use of these frequencies by amateur stations shall not cause harmful interference to LORAN-A system. If an amateur station causes such interference, operation on the frequencies involved must cease if so directed by the Commission.

## (2) Operation shall be limited to:

Area	Maximum DC plate input power in watts							
	1800-1825 kHz	1825-1850 kHz	1850-1875 kHz	1875-1900 kHz	1900-1925 kHz	1925-1950 kHz	1950-1975 kHz	1975-2000 kHz
	Day/Night	Day/Night	Day/Night	Day/Night	Day/Night	Day/Night	Day/Night	Day/Night
Alabama	500/100	100/25	0	0	0	0	100/25	500/100
Alaska	1000/200	500/100	500/100	100/25	0	0	0	0
Arizona	1000/200	500/100	500/100	0	0	0	0	0
Arkansas	1000/200	500/100	100/25	0	0	100/25	100/25	500/100
California	1000/200	500/100	500/100	100/25	0	0	0	0
Colorado	1000/200	500/100	200/50	0	0	0	0	200/50
Connecticut	500/100	100/25	0	0	0	0	0	0
Delaware	500/100	100/25	0	0	0	0	0	100/25
District of Columbia	500/100	100/25	0	0	0	0	0	100/25
Florida	500/100	100/25	0	0	0	0	100/25	500/100
Georgia	500/100	100/25	0	0	0	0	0	200/50
Hawaii	0	0	0	0	200/50	100/25	100/25	500/100
Idaho	1000/200	500/100	500/100	100/25	100/25	100/25	100/25	500/100
Illinois	1000/200	500/100	100/25	0	0	0	0	200/50
Indiana	1000/200	500/100	100/25	0	0	0	0	200/50
Iowa	1000/200	500/100	200/50	0	0	100/25	100/25	500/100
Kansas	1000/200	500/100	100/25	0	0	100/25	100/25	500/100
Kentucky	1000/200	500/100	100/25	0	0	0	0	200/50
Louisiana	500/100	100/25	0	0	0	0	100/25	500/100
Maine	500/100	100/25	0	0	0	0	0	0
Maryland	500/100	100/25	0	0	0	0	0	100/25
Massachusetts	500/100	100/25	0	0	0	0	0	0
Michigan	1000/200	500/100	100/25	0	0	0	0	100/25
Minnesota	1000/200	500/100	500/100	100/25	100/25	100/25	100/25	500/100
Mississippi	500/100	100/25	0	0	0	0	100/25	500/100
Missouri	1000/200	500/100	100/25	0	0	100/25	100/25	500/100
Montana	1000/200	500/100	500/100	100/25	100/25	100/25	100/25	500/100
Nebraska	1000/200	500/100	200/50	0	0	100/25	100/25	500/100
Nevada	1000/200	500/100	500/100	100/25	0	0	0	0
New Hampshire	500/100	100/25	0	0	0	0	0	0
New Jersey	500/100	100/25	0	0	0	0	0	0
New Mexico	1000/200	500/100	100/25	0	0	100/25	500/100	1000/200
New York	500/100	100/25	0	0	0	0	0	0
North Carolina	500/100	100/25	0	0	0	0	0	100/25
North Dakota	1000/200	500/100	500/100	100/25	100/25	100/25	100/25	500/100
Ohio	1000/200	500/100	100/25	0	0	0	0	100/25
Oklahoma	1000/200	500/100	500/100	100/25	0	100/25	100/25	500/100
Oregon	1000/200	500/100	0	0	0	0	0	0
Pennsylvania	500/100	100/25	0	0	0	0	0	0
Rhode Island	500/100	100/25	0	0	0	0	0	0
South Carolina	500/100	100/25	0	0	0	0	0	200/50
South Dakota	1000/200	500/100	500/100	100/25	100/25	100/25	100/25	500/100
Tennessee	1000/200	500/100	100/25	0	0	0	0	200/50
Texas	500/100	100/25	0	0	0	0	0	200/50
Utah	1000/200	500/100	500/100	100/25	100/25	0	0	100/25
Vermont	500/100	100/25	0	0	0	0	0	0
Virginia	500/100	100/25	0	0	0	0	0	100/25
Washington	1000/200	500/100	500/100	100/25	0	0	0	0
West Virginia	1000/200	500/100	100/25	0	0	0	0	100/25
Wisconsin	1000/200	500/100	200/50	0	0	0	0	200/50
Wyoming	1000/200	500/100	500/100	100/25	100/25	0	0	200/50
Puerto Rico	500/100	100/25	0	0	0	0	0	200/50
Virgin Islands	500/100	100/25	0	0	0	0	0	200/50
Swan Island	500/100	100/25	0	0	0	0	100/25	500/100
Serrana Bank	500/100	100/25	0	0	0	0	100/25	500/100
Roncador Key	500/100	100/25	0	0	0	0	100/25	500/100
Navassa Island	500/100	100/25	0	0	0	0	0	200/50
Baker, Canton, Enderbury, Howland	100/25	0	0	100/25	100/25	0	0	100/25
Guam, Johnston, Midway	0	0	0	0	100/25	0	0	100/25
American Samoa	200/50	0	0	200/50	200/50	0	0	200/50
Wake	100/25	0	0	100/25	0	0	0	0
Palmyra, Jarvis	0	0	0	0	200/50	0	0	200/50

(3) Where, in adjacent regions or subregions, a band of frequencies is allocated to different services of the same category, the basic principle is the equality of right to operate. Accordingly, the stations of each service in one region or subregion must operate so as not to cause harmful interference to services in the other regions or subregions (No. 117, the Radio Regulations, Geneva, 1959).

(4) 3900-4000 kHz and 7100-7300 kHz are not available in the following U.S. possessions: Baker, Canton, Enderbury, Guam, Howland, Jarvis, Palmyra, American Samoa, and Wake Islands.

(5) Amateur stations shall not cause interference to the Government radiolocation service.

(6) Not available in those portions of Texas and New Mexico bounded by latitude 33°24' N., and 31°53' N., and longitude 105°40' W. and 106°40' W. between the hours 0500 and 1800 local time, Monday through Friday, except to stations authorized to operate in an organized civil defense network when civil defense emergencies exist or when arrangements have been made with the Commission Engineer in Charge at Dallas, Tex., and the Area Frequency Coordinator at White Sands, N. Mex., for drills at specific dates and times.

(7) In the following areas the d.c. plate input power to the final transmitter stage shall not exceed 50 watts, except when authorized by the appropriate Commission Engineer in Charge and the appropriate Military Area Frequency Coordinator.

(i) Those portions of Texas and New Mexico bounded by latitude 33°24' N., 31°53' N., and longitude 105°40' W. and 106°40' W.

(ii) The State of Florida, including the Key West area and the areas enclosed within circles of 200-mile radius centered at 28°21' N., 80°43' W. and 30°30' N., 86°30' W.

(iii) The State of Arizona.

(iv) Those portions of California and Nevada south of latitude 37°10' N. and the area within a 200-mile radius of 34°09' N., 119°11' W.

(8) No protection in the band 2400-2500 MHz is afforded from interference due to the operation of industrial, scientific, and medical devices on 2450 MHz.

(9) No protection in the band 5725-5875 MHz is afforded from interference due to the operation of industrial, scientific and medical devices on 5800 MHz.

(10) No protection in the band 24.00-24.25 GHz is afforded from interference due to the operation of industrial, scientific and medical devices on 24.125 GHz.

(11) The use of A3 and F3 in this band is limited to amateur radio stations located outside Region 2.

(12) Amateur stations shall not cause interference to the Fixed-Satellite Service operating in the band 3400-3500 MHz.

(13) The frequency 4383.8 kHz, maximum power 150 watts, may be used by any station authorized under this part to communicate with any other station authorized in the State of Alaska for emergency communications. No airborne operations will be permitted on this frequency. Additionally, all stations operating on

this frequency must be located in or within 50 nautical miles of the State of Alaska.

(c) The following transmitting frequency bands and the associated emission authorized in paragraph (a) of this section are available for repeater stations, including both input (receiving) and output (transmitting):

*Frequency Band (MHz)*

29.5-29.7

52.0-54.0

146.0-148.0

222.0-225.0

442.0-450.0

any amateur frequency above 1215 MHz.

**§ 97.63 Individual frequency not specified.**

Transmissions by an amateur station may be on any frequency within any authorized amateur band. Sideband frequencies resulting from keying or modulating a carrier wave shall be confined within the authorized amateur band.

**§ 97.65 Emission limitations.**

(a) Type A0 emission, where not specifically designated in the bands listed in § 97.61, may be used for short periods of time when required for authorized remote control purposes or for experimental purposes. However, these limitations do not apply where type A0 emission is specifically designated.

(b) Whenever code practice, in accordance with § 97.91(d), is conducted in bands authorized for A3 emission, tone modulation of the radiotelephone transmitter may be utilized when interspersed with appropriate voice instructions.

(c) On frequencies below 29.0 MHz and between 50.1 and 52.5 MHz, the bandwidth of an F3 emission (frequency or phase modulation) shall not exceed that of an A3 emission having the same audio characteristics; and the purity and stability of emissions shall comply with the requirements of § 97.73.

(d) On frequencies below 50 MHz, the bandwidth of A5 and F5 emissions shall not exceed that of an A3 single sideband emission.

(e) On frequencies between 50 MHz and 225 MHz, single sideband or double sideband A5 emission may be used and the bandwidth shall not exceed that of an A3 single sideband or double sideband signal respectively. The bandwidth of F5 emission shall not exceed that of an A3 single sideband emission.

(f) Below 225 MHz, A3 and A5 emissions may be used simultaneously on the same carrier frequency provided the total bandwidth does not exceed that of an A3 double sideband emission.

**§ 97.67 Maximum authorized power.**

(a) Except for power restrictions as set forth in § 97.61 and paragraph (d) below each amateur transmitter may be operated with a power input not exceeding one kilowatt to the plate circuit of the final amplifier stage of an amplifier oscillator transmitter or to the plate circuit of an oscillator transmitter. An amateur transmitter operating with a power input exceed-

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ing 900 watts to the plate circuit shall provide means for accurately measuring the plate power input to the vacuum tube or tubes supplying power to the antenna.

(b) Notwithstanding the provisions of paragraph (a) of this section, amateur stations shall use the minimum amount of transmitter power necessary to carry out the desired communications.

(c) Within the limitations of paragraphs (a) and (b) of this section, the effective radiated power of a repeater station shall not exceed that specified for the antenna height above average terrain in the following table:

Antenna height above average terrain	Maximum effective radiated power for frequency bands above			
	52 MHz	146 MHz	442 MHz	1215 MHz
Below 50 feet	100 watts	800 watts	Paragraphs (a) and (b)	-----
50 to 99 feet	100 watts	400 watts	-----do-----	-----
100 to 499 feet	50 watts	400 watts	800 watts	Paragraphs (a) and (b)
500 to 999 feet	25 watts	200 watts	800 watts	Do
Above 1,000 feet	25 watts	100 watts	400 watts	Do

(d) In the frequency bands 3700-3750 kHz, 7100-7150 kHz (7050-7075 kHz when the terrestrial location of the station is not within Region 2) 21,100-21,200 kHz and 28,100-28,200 kHz, the power input to the transmitter final amplifying stage supplying radio frequency energy to the antenna shall not exceed 250 watts, exclusive of power for heating the cathode of a vacuum tube(s).

### § 97.69 Radio teleprinter transmissions.

The following special conditions shall be observed during the transmission of radio teleprinter signals on authorized frequencies by amateur stations:

(a) A single channel five-unit (start-stop) teleprinter code shall be used which shall correspond to the International Telegraphic Alphabet No. 2 with respect to all letters and numerals (including the slant sign or fraction bar) but special signals may be employed for the remote control of receiving printers, or for other purposes, in "figures" positions not utilized for numerals. In general, this code shall conform as nearly as possible to the teleprinter code or codes in common commercial usage in the United States.

(b) The normal transmitting speed of the radio teleprinter signal keying equipment shall be adjusted as closely as possible to one of the standard teleprinter speeds, namely, 60 (45 bauds), 67 (50 bauds), 75 (56.25 bauds) or 100 (75 bauds) words per minute, and in any event, within the range of  $\pm 5$  words per minute of the selected standard speed.

(c) When frequency shift keying (type F1 emission) is utilized, the deviation in frequency from the mark signal to space signal, or from the space signal to the mark signal, shall be less than 900 hertz.

(d) When audio frequency shift keying (type A2 or type F2 emission) is utilized, the highest fundamental modulating audio frequency shall not exceed 3000 hertz, and the difference between the modulating audio frequency for the mark signal and that for the space signal shall be less than 900 hertz.

### § 97.71 Transmitter power supply.

The licensee of an amateur station using frequencies below 144 megahertz shall use adequately filtered direct-current plate power supply for the transmitting equipment to minimize modulation from this source.

### § 97.73 Purity and stability of emissions.

Spurious radiation from an amateur station being operated with a carrier frequency below 144 megahertz shall be reduced or eliminated in accordance with good engineering practice. This spurious radiation shall not be of sufficient intensity to cause interference in receiving equipment of good engineering design including adequate selectivity characteristics, which is tuned to a frequency or frequencies outside the frequency band of emission normally required for the type of emission being employed by the amateur station. In the case of A3 emission, the amateur transmitter shall not be modulated to the extent that interfering spurious radiation occurs, and in no case shall the emitted carrier wave be amplitude-modulated in excess of 100 percent. Means shall be employed to insure that the transmitter is not modulated in excess of its modulation capability for proper technical operation. For the purpose of this section a spurious radiation is any radiation from a transmitter which is outside the frequency band of emission normal for the type of transmission employed, including any component whose frequency is an integral multiple or submultiple of the carrier frequency (harmonics and subharmonics), spurious modulation products, key clicks, and other transient effects, and parasite oscillations. When using amplitude modulation on frequencies below 144 megahertz, simultaneous frequency modulation is not permitted and when using frequency modulation on frequencies below 144 megahertz simultaneous amplitude modulation is not permitted. The frequency of the emitted carrier wave shall be as constant as the state of the art permits.

### § 97.75 Frequency measurement and regular check.

The licensee of an amateur station shall provide for measurement of the emitted carrier frequency or frequencies and shall establish procedures for making such measurement regularly. The measurement of the emitted carrier frequency or frequencies shall be made by means independent of the means used to control the radio frequency or frequencies generated by the transmitting apparatus and shall be of sufficient accuracy to assure operation within the amateur frequency band used.

## SUBPART D—OPERATING REQUIREMENTS AND PROCEDURES

### GENERAL

### § 97.77 Practice to be observed by all licensees.

In all respects not specifically covered by these regulations each amateur station shall be operated in

accordance with good engineering and good amateur practice.

#### § 97.79 Control operator requirements.

(a) The licensee of an amateur station shall be responsible for its proper operation.

(b) Every amateur radio station, when in operation, shall have a control operator at an authorized control point. The control operator shall be on duty, except where the station is operated under automatic control. The control operator may be the station licensee, if a licensed amateur radio operator, or may be another amateur radio operator with the required class of license and designated by the station licensee. The control operator shall also be responsible, together with the station licensee, for the proper operation of the station.

(c) An amateur station may only be operated in the manner and to the extent permitted by the operator privileges authorized for the class of license held by the control operator, but may exceed those of the station licensee provided proper station identification procedures are performed.

(d) The licensee of an amateur radio station may permit any third party to participate in amateur radio communication from his station, provided that a control operator is present and continuously monitors and supervises the radio communication to insure compliance with the rules.

#### § 97.81 Authorized apparatus.

An amateur station license authorizes the use under control of the licensee of all transmitting apparatus at the fixed location specified in the station license which is operated on any frequency, or frequencies allocated to the amateur service, and in addition authorizes the use, under control of the licensee, of portable and mobile transmitting apparatus operated at other locations.

#### § 97.83 Availability of operator license.

The original operator license of each operator shall be kept in the personal possession of the operator while operating an amateur station. When operating an amateur station at a fixed location, however, the license may be posted in a conspicuous place in the room occupied by the operator. The license shall be available for inspection by any authorized Government official whenever the operator is operating an amateur station and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost or destroyed, and request has been made for a duplicate license in accordance with § 97.57. No recognition shall be accorded to any photocopy of an operator license; however, nothing in this section shall be construed to prohibit the photocopying for other purposes of any amateur radio operator license.

#### § 97.85 Availability of station license.

The original license of each amateur station or a photocopy thereof shall be posted in a conspicuous place in the room occupied by the licensed operator while the station is being operated at a fixed location or shall be kept in his personal possession. When the station is operated at other than a fixed location, the original station license or a photocopy thereof shall be kept in the personal possession of the station licensee (or a licensed representative) who shall be present at the station while it is being operated as a portable or mobile station. The original station license shall be available for inspection by any authorized Government official at all times while the station is being operated and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost, or destroyed, and request has been made for a duplicate license in accordance with § 97.57.

#### § 97.87 Station identification.

(a) An amateur station shall be identified by the transmission of its call sign at the beginning and end of each single transmission or exchange of transmissions and at intervals not to exceed 10 minutes during any single transmission or exchange of transmissions of more than 10 minutes duration. Additionally, at the end of an exchange of telegraphy (other than teleprinter) or telephony transmissions between amateur stations, the call sign (or the generally accepted network identifier) shall be given for the station, or for at least one of the group of stations, with which communication was established.

(b) Under conditions when the control operator is other than the station licensee, the station identification shall be the assigned call sign for that station. However, when a station is operated within the privileges of the operator's class of license but which exceeds those of the station licensee, station identification shall be made by following the station call sign with the operator's primary station call sign (i.e. WN4XYZ/W4XX).

(c) A repeater station shall be identified by radiotelephony or by radio telegraphy when in service at intervals not to exceed 5 minutes at a level of modulation sufficient to be intelligible through the repeated transmission.

(d) A control station must be identified by its assigned station call sign unless its emissions contain the call sign identification of the remotely controlled station.

(e) An auxiliary link station must be identified by its assigned station call sign unless its emissions contain the call sign of its associated station.

(f) When operating under the authority of an Interim Amateur Permit with privileges authorized by the Permit, but which exceed the privileges of the licensee's permanent operator license, the station must be identified in the following manner:

(1) On radiotelephony, by the transmission of the



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station call sign, followed by the word "interim", followed by the special identifier shown on the Interim Permit;

(2) On radiotelegraphy, by the transmission of the station call sign, followed by the fraction bar  $\overline{DN}$ , followed by the special identifier shown on the interim permit.

(g) The identification required by this section shall be given on each frequency being utilized for transmission and shall be transmitted either by telegraphy using the international Morse code, or by telephony, using the English language. If the identification required by this section is made by an automatic device used only for identification by telegraphy, the code speed shall not exceed 20 words per minute. The Commission encourages the use of a nationally or internationally recognized standard phonetic alphabet as an aid for correct telephone identification.

### § 97.88 Operation of a remotely controlled station.

An amateur radio station may be remotely controlled only from an authorized control point, and only where there is compliance with the following:

(a) A photocopy of the remotely controlled station license must be posted in a conspicuous place at the authorized control point(s), and at the remotely controlled transmitter location. A copy of the system network diagram must be retained at each control point. The transmitting antenna, transmission line, or mast, as appropriate, associated with the remotely controlled transmitter must bear a durable tag marked with the station call sign, the name of the station licensee and other information so that the control operator can readily be contacted by Commission personnel.

(b) The control link equipment and the remotely controlled station must be accessible only to persons authorized by the licensee. Protection against both inadvertent and unauthorized deliberate emissions must be provided. In the event unauthorized emissions occur, the station operation must be suspended until such time as adequate protection is incorporated, or until there is reasonable assurance that unauthorized emissions will not recur.

(c) Except for operation under automatic control, as provided by §§ 97.110(c) and 97.111(g), a control operator designated by the licensee must be present at an authorized control point while the station is being remotely controlled. Immediately prior to, and during the periods the remotely controlled station is in operation, the frequencies used for emission by the remotely controlled transmitter must be continuously monitored by the control operator. The control operator must terminate transmission upon any deviation from the rules.

(d) Provisions must be incorporated to limit transmission to a period of no more than 3 minutes in the event of malfunction in the control link.

(e) A repeater station may be operated by radio remote control only where the control link utilizes frequencies other than the repeater station receiving frequencies.

### § 97.89 Points of Communications.

(a) Amateur stations may communicate with:

(1) Other amateur stations, excepting those prohibited by Appendix 2.

(2) Stations in other services licensed by the Commission and with U.S. Government stations for civil defense purposes in accordance with Subpart F of this part, in emergencies and, on a temporary basis, for test purposes.

(3) Any station which is authorized by the Commission to communicate with amateur stations.

(b) Amateur stations may be used for transmitting signals, or communications, or energy, to receiving apparatus for the measurement of emissions, temporary observation of transmission phenomena, radio control of remote objects, and similar experimental purposes and for the purposes set forth in § 97.91.

(c) [Reserved]

(d) Control stations and auxiliary link stations may not be used to communicate with any other station than those shown in the system network diagram.

### § 97.91 One-way communications.

In addition to the experimental one-way transmission permitted by § 97.89, the following kinds of one-way communications, addressed to amateur stations, are authorized and will not be construed as broadcasting: (a) Emergency communications, including bona-fide emergency drill practice transmissions; (b) Information bulletins consisting solely of subject matter having direct interest to the amateur radio service as such; (c) Round-table discussions or net-type operations where more than two amateur stations are in communication, each station taking a turn at transmitting to other station(s) of the group; and (d) Code practice transmissions intended for persons learning or improving proficiency in the international Morse code.

### § 97.93 Modulation of carrier.

Except for brief tests or adjustments, an amateur radiotelephone station shall not emit a carrier wave on frequencies below 51 megahertz unless modulated for the purpose of communication. Single audiofrequency tones may be transmitted for test purposes of short duration for the development and perfection of amateur radio telephone equipment.

### STATION OPERATION AWAY FROM AUTHORIZED LOCATION

### § 97.95 Operations away from the authorized fixed operation station location.

(a) Operation within the United States, its territories or possessions is permitted as follows:

(1) When there is no change in the authorized fixed operation station location, an amateur radio station other than a military recreation, auxiliary link, or special event station, may be operated under its station license anywhere in the United States, its territories or possessions, as a portable or mobile operation, subject to § 97.61.



(2) When the authorized permanent station location is changed, formal application (FCC Form 610 for an individual station license and FCC Form 610-B for an amateur club or military recreation station license) must be submitted to the Commission prior to any operation and within 4 months of the move for the purpose of modifying the station license to show the new permanent station location. Operation at the new location is permitted under the license for the former station from the date the modification application is mailed until advised of Commission action on that application.

(b) When outside the continental limits of the United States, its territories, or possessions, an amateur radio station may be operated as portable or mobile only under the following conditions:

(1) Operation may not be conducted within the jurisdiction of a foreign government except pursuant to, and in accordance with express authority granted to the licensee by such foreign government. When a foreign government permits Commission licensees to operate within its territory, the amateur frequency bands which may be used shall be as prescribed or limited by that government. (See Appendix 4 of this Part for the text of treaties or agreements between the United States and foreign governments relative to reciprocal amateur radio operation.)

(2) When outside the jurisdiction of a foreign government, operation may be conducted within Region 2 on any amateur frequency band between 7.9 MHz and 148 MHz, inclusive, and when not within Region 2, operation may be conducted only in the amateur bands 7.0-7.1 MHz, 14.00-14.35 MHz, 21.00-21.45 MHz, and 28.0-29.7 MHz.

Note: Region 2 is defined as follows. On the east, a line (B) extending from the North Pole along meridian 10° west of Greenwich to its intersection with parallel 72° north, thence by Great Circle Arc to the intersection of meridian 50° west and parallel 40° north, thence by Great Circle Arc to the intersection of meridian 20° west and parallel 10° south, thence along meridian 20° west to the South Pole. On the west, a line (C) extending from the North Pole by Great Circle Arc to the intersection of parallel 65°30' north with the international boundary in Bering Strait, thence by Great Circle Arc to the intersection of meridian 165° east of Greenwich and parallel 50° north, thence by Great Circle Arc to the intersection of meridian 170° west and parallel 10° north, thence along parallel 10° north to its intersection with meridian 120° west, thence along meridian 120° west to the South Pole.

#### SPECIAL PROVISIONS

##### § 97.99 Stations used only for radio control of remote model crafts and vehicles.

An amateur transmitter when used for the purpose of transmitting radio signals intended only for the control of a remote model craft or vehicle and having mean output power not exceeding one watt may be operated under the special provisions of this section provided an executed Transmitter Identification Card (FCC Form 452-C) or a plate made of a durable substance indicating the station call sign and licensee's name and address is affixed to the transmitter.

(a) Station identification is not required for transmissions directed only to a remote model craft or vehicle.

(b) Transmissions containing only control signals directed only to a remote model craft or vehicle are not considered to be codes or ciphers in the context of the meaning of § 97.117.

(c) Station logs need not indicate the times of commencing and terminating each transmission or series of transmissions.

##### § 97.101 Mobile stations aboard ships or aircraft.

In addition to complying with all other applicable rules, an amateur mobile station operated on board a ship or aircraft must comply with all of the following special conditions: (a) The installation and operation of the amateur mobile station shall be approved by the master of the ship or captain of the aircraft; (b) The amateur mobile station shall be separate from and independent of all other radio equipment, if any, installed on board the same ship or aircraft; (c) The electrical installation of the amateur mobile station shall be in accord with the rules applicable to ships or aircraft as promulgated by the appropriate government agency; (d) The operation of the amateur mobile station shall not interfere with the efficient operation of any other radio equipment installed on board the same ship or aircraft; and (e) The amateur mobile station and its associated equipment, either in itself or in its method of operation, shall not constitute a hazard to the safety of life or property.

#### LOGS

##### § 97.103 Station log requirements.

An accurate legible account of station operation shall be entered into a log for each amateur radio station. The following items shall be entered as a minimum:

(a) The call sign of the station, the signature of the station licensee, or a photocopy of the station license.

(b) The locations and dates upon which fixed operation of the station was initiated and terminated. If applicable, the location and dates upon which portable operation was initiated and terminated at each location.

(1) The date and time periods the duty control operator for the station was other than the station licensee, and the signature and primary station call sign of that duty control operator.

(2) A notation of third party traffic sent or received, including names of all third parties, and a brief description of the traffic content. This entry may be in a form other than written, but one which can be readily transcribed by the licensee into written form.

(3) Upon direction of the Commission, additional information as directed shall be recorded in the station log.

(c) The log of a remotely controlled station shall have entered the address for each control point and a functional block diagram and a technical explanation sufficient to describe the operation of the control link. Additionally, the following shall be entered:

(1) Description of the measures taken for protection

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against access to the remote station by unauthorized persons.

(2) Description of the measures taken for protection against unauthorized station operation, either through activation of the control link or otherwise.

(3) Description of the provisions for shutting down the station in case of control link malfunction.

(4) Description of the means provided for monitoring the transmitting frequencies.

(5) Photocopies of all control station licenses and all auxiliary link station licenses.

(d) When a station has one or more associated stations, i.e., control station and/or auxiliary link station, a system network diagram shall be entered.

(e) The log of a control station or an auxiliary link station shall have the following information entered:

(1) A system network diagram for each system with which the station is associated.

(2) The station transmitting band(s).

(3) Description of the means provided for monitoring the transmitting frequencies.

(4) The transmitter power input and justification that such power is in compliance with § 97.67(b).

(5) If an auxiliary link station is being operated by remote control, all of the information required by paragraph (b) of this section shall also be entered.

(f) Notwithstanding the provisions of § 97.105, the log entries required by paragraphs (c) and (d) and (e) of this section shall be retained in the station log until such time as they are amended.

### § 97.105 Retention of logs.

The station log shall be preserved for a period of at least 1 year following the last date of entry and retained in the possession of the licensee. Copies of the log, including the sections required to be transcribed by § 97.103, shall be available to the Commission for inspection.

## EMERGENCY OPERATIONS

### § 97.107 Operation in emergencies.

In the event of an emergency disrupting normally available communication facilities in any widespread area or areas, the Commission, in its discretion, may declare that a general state of communications emergency exists, designate the area or areas concerned, and specify the amateur frequency bands, or segments of such bands, for use only by amateurs participating in emergency communication within or with such affected area or areas. Amateurs desiring to request the declaration of such a state of emergency should communicate with the Commission's Engineer in Charge of the area concerned. Whenever such declaration has been made, operation of and with amateur stations in the area concerned shall be only in accordance with the requirements set forth in this section, but such requirements shall in no wise affect other normal amateur communication in the affected area when conducted on frequencies not designated for emergency operation.

(a) All transmissions within all designated amateur communications bands<sup>1</sup> other than communications relating directly to relief work, emergency service, or the establishment and maintenance of efficient amateur radio networks for the handling of such communications shall be suspended. Incidental calling, answering, testing or working (including casual conversations, remarks or messages) not pertinent to constructive handling of the emergency situation shall be prohibited within these bands.

(b) The Commission may designate certain amateur stations to assist in the promulgation of information relating to the declaration of a general state of communications emergency, to monitor the designated amateur emergency communications bands, and to warn non-complying stations observed to be operating in those bands. Such station, when so designated, may transmit for that purpose on any frequency or frequencies authorized to be used by that station, provided such transmissions do not interfere with essential emergency communications in progress; however, such transmissions shall preferably be made on authorized frequencies immediately adjacent to those segments of the amateur bands being cleared for the emergency. Individual transmissions for the purpose of advising other stations of the existence of the communications emergency shall refer to this section by number (§ 97.107) and shall specify, briefly and concisely, the date of the Commission's declaration, the area and nature of the emergency, and the amateur frequency bands or segments of such bands which constitute the amateur emergency communications bands at the time. The designated stations shall not enter into discussions with other stations beyond furnishing essential facts relative to the emergency, or acting as advisors to stations desiring to assist in the emergency, and the operators of such designated stations shall report fully to the Commission the identity of any stations failing to comply, after notice, with any of the pertinent provisions of this section.

(c) The special conditions imposed under the provisions of this section shall cease to apply only after the Commission, or its authorized representative, shall have declared such general state of communications emergency to be terminated; however, nothing in this paragraph shall be deemed to prevent the Commission from modifying the terms of its declaration from time to time as may be necessary during the period of a communications emergency, or from removing those conditions with respect to any amateur frequency band or segment of such band which no longer appears essential to the conduct of the emergency communications.

<sup>1</sup> The frequency 4383.8 kHz may be used by any station authorized under this part to communicate with any other station in the State of Alaska for emergency communications. No airborne operations will be permitted on this frequency. Additionally, all stations operating on this frequency must be located in or within 50 nautical miles of the State of Alaska.

## OPERATION OF ADDITIONAL STATIONS

**§ 97.109 Operation of a control station.**

(a) Amateur frequency bands above 220 MHz, excepting 435 to 438 MHz, may be used for emissions by a control station. Frequencies below 225 MHz used for control links must be monitored by the control operator immediately prior to, and during, periods of operation.

(b) Where a remotely controlled station has been authorized to be operated from one or more remote control stations, those remote control stations may be operated either mobile or portable.

**§ 97.110 Operation of an auxiliary link station.**

(a) An auxiliary link station may use amateur frequency bands above 220 MHz, excepting 435 to 438 MHz, for emissions. Except as provided in § 97.110(c), frequencies below 225 MHz used by an auxiliary link station shall be monitored by the control operator immediately prior to, and during, periods of operation.

(b) An auxiliary link station may only be used for fixed operation from the location specified on the station license.

(c) An auxiliary link station licensed either for operation by local control or remote control may also be operated by automatic control when it is operated as a part of a repeater station system which is being operated under automatic control. Both the auxiliary link station and the repeater station must appear on the system network diagram.

**§ 97.111 Operation of a repeater station.**

(a) Emissions from a repeater station shall be discontinued within 5 seconds after cessation of radio-communications by the user station. Provisions to automatically limit the access to a repeater station may be incorporated, but are not mandatory.

(b) Except for automatic control operations as provided in paragraph (g) of this section, the transmitting and receiving frequencies utilized by the repeater station shall be continuously monitored by the control operator immediately prior to, and during, periods of operation.

(c) A repeater station may concurrently receive and retransmit amateur radio signals on one or more frequency bands authorized for repeater stations, but may not concurrently retransmit on more than one frequency within the same band except when specifically approved by the Commission. A repeater station authorized to operate in conjunction with one or more auxiliary link stations for relaying radio signals, received at another location(s), to the repeater station may utilize input (receiving) frequencies not available for repeater stations, provided the input frequencies to the auxiliary link station(s) are in frequency bands authorized to repeater stations.

(d) A repeater station shall be operated in a manner so as to assume that the station is not used for one-way radiocommunication other than provided for in § 97.91.

(e) A station licensed as a repeater station may only

be operated as a repeater station, excepting for short periods for testing or for emergencies.

(f) When in operation, the log of a repeater station must also show the following information for each frequency band in use.

(1) Location of the station transmitting antenna, marked upon a topographic map having a scale of 1:250,000, and contour intervals.<sup>1</sup>

(2) The transmitting antenna height above average terrain.<sup>2</sup>

(3) The effective radiated power in the horizontal plane for the main lobe of the antenna pattern, calculated for maximum transmitter output power.

(4) The transmitter output power.

(5) The loss in the transmission line between the transmitter and the antenna, expressed in decibels.

(6) The relative gain in the horizontal plane of the transmitting antenna.

(7) The horizontal and vertical radiation patterns of the transmitting antenna, with reference to true north (for horizontal pattern only), expressed as relative field strength (voltage) or in decibels, drawn upon polar coordinate graph paper, and method of determining the patterns.

(g) A repeater station licensed either for local control or for remote control may also be operated under automatic control where

(1) Devices and procedures have been implemented to assure that compliance with the rules can be accomplished without the duty control operator present at the control point at all times the station is in operation.

(2) All radiocommunications transmitted by the station are monitored by the duty control operator in real-time, or are recorded so that they can be reproduced and reviewed within 72 hours. The recordings shall be preserved for a period of at least 30 days, in the possession of the station licensee, and must be made available to the Commission upon request. However, real-time monitoring, or recording and review of repeater operation is not required when the facility is operated as a closed repeater, i.e., the repeater station employs means to restrict usage to persons specifically authorized by the control operator or station licensee

(3) Upon notification by the Commission of improper operation of a station under automatic control, said operation must be immediately discontinued until all deficiencies have been corrected

## SUBPART E—PROHIBITED PRACTICES AND ADMINISTRATIVE SANCTIONS

### PROHIBITED TRANSMISSIONS AND PRACTICES

**§ 97.112 No remuneration for use of station.**

(a) An amateur station shall not be used to transmit or receive messages for hire, nor for communication

<sup>1</sup> Indexes and ordering information for suitable maps are available from U.S. Geological Survey, Washington, D.C. 20242, or Federal Center, Denver, Colorado 80226.

<sup>2</sup> See Appendix 5.

**§ 97.137 Answers to notices of violations.**

Any licensee receiving official notice of a violation of the terms of the Communications Act of 1934, as amended, any legislative act, Executive order, treaty to which the United States is a party, or the rules and regulations of the Federal Communications Commission, shall, within 10 days from such receipt, send a written answer direct to the office of the Commission.

*Provided, however,* That if an answer cannot be sent or an acknowledgment made within such 10-day period by reason of illness or other unavoidable circumstances, acknowledgment and answer shall be made at the earliest practicable date with a satisfactory explanation of the delay. The answer to each notice shall be complete in itself and shall not be abbreviated by reference to other communications or answers to other notices. If the notice relates to some violation that may be due to the physical or electrical characteristics of transmitting apparatus, the answer shall state fully what steps, if any, are taken to prevent future violations, and if any new apparatus is to be installed, the date such apparatus was ordered, the name of the manufacturer, and promised date of delivery. If the notice of violation relates to some lack of attention to or improper operation of the transmitter, the name of the operator in charge shall be given.

## SUBPART F—RADIO AMATEUR CIVIL EMERGENCY SERVICE (RACES)

## GENERAL

**§ 97.161 Basis and purpose.**

The Radio Amateur Civil Emergency Service provides for amateur radio operation for civil defense communications purposes only, during periods of local, regional or national civil emergencies, including any emergency which may necessitate invoking of the President's War Emergency Powers under the provisions of section 606 of the Communications Act of 1934, as amended.

**§ 97.163 Definitions.**

For the purposes of this Subpart, the following definitions are applicable:

(a) *Radio Amateur Civil Emergency Service.* A radio communication service conducted by volunteer licensed amateur radio operators, for providing emergency radio communications to local, regional, or state civil defense organizations.

(b) *RACES station.* An amateur radio station licensed to a civil defense organization, at a specific land location, for the purpose of providing the facilities for amateur radio operators to conduct amateur radio communications in the Radio Amateur Civil Emergency Service.

**§ 97.165 Applicability of rules.**

In all cases not specifically covered by the provisions contained in this Subpart, amateur radio stations and

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means.

obtain or attempt to obtain, or assist another to obtain or attempt to obtain, an operator license by fraudulent

**§ 97.131 Restricted operation.**

(a) If the operation of an amateur station causes general interference to the reception of transmissions from stations operating in the domestic broadcast service when receivers of good engineering design including adequate selectivity characteristics are used to receive such transmission and this fact is made known to the amateur station licensee, the amateur station shall not be operated during the hours from 8 p.m. to 10:30 p.m., local time, and on Sunday for the additional period from 10:30 a.m. until 1 p.m., local time, upon the frequency or frequencies used when the interference is created.

(b) In general, such steps as may be necessary to minimize interference to stations operating in other services may be required after investigation by the Commission.

**§ 97.133. Second notice of same violation.**

In every case where an amateur station licensee is cited within a period of 12 consecutive months for the second violation of the provisions of §§ 97.61, 97.63, 97.65, 97.71, or 97.73, the station licensee, if directed to do so by the Commission, shall not operate the station and shall not permit it to be operated from 6 p.m. to 10:30 p.m., local time, until written notice has been received authorizing the resumption of full-time operation. This notice will not be issued until the licensee has reported on the results of tests which he has conducted with at least two other amateur stations at hours other than 6 p.m. to 10:30 p.m., local time. Such tests are to be made for the specific purpose of aiding the licensee in determining whether the emissions of the station are in accordance with the Commission's rules. The licensee shall report to the Commission the observations made by the cooperating amateur licensee in relation to the reported violations. This report shall include a statement as to the corrective measures taken to insure compliance with the rules.

**§ 97.135 Third notice of same violation.**

In every case where an amateur station licensee is cited within a period of 12 consecutive months for the third violation of §§ 97.61, 97.63, 97.65, 97.71, or 97.73, the station licensee, if directed by the Commission, shall not operate the station and shall not permit it to be operated from 8 a.m. to 12 midnight, local time, except for the purpose of transmitting a prearranged test to be observed by a monitoring station of the Commission to be designated in each particular case. The station shall not be permitted to resume operation during these hours until the licensee is authorized by the Commission, following the test, to resume full-time operation. The results of the test and the licensee's record shall be considered in determining the advisability of suspending the operator license or revoking the station license, or both.

RACES stations shall be governed by the provisions of the rules governing amateur radio stations and operators (Subpart A through E of this part).

#### STATION AUTHORIZATIONS

##### § 97.169 Station license required.

No transmitting station shall be operated in the Radio Amateur Civil Emergency Service unless:

- The station is licensed as a RACES station by the Federal Communications Commission, or
- The station is an amateur radio station licensed by the Federal Communications Commission, and is certified by the responsible civil defense organization as registered with that organization.

##### § 97.171 Eligibility for RACES station license.

A RACES station will only be licensed to a local, regional, or state civil defense organization.

##### § 97.173 Application for RACES station license.

(a) Each application for a RACES station license shall be made on the FCC Form 610-B.

(b) The application shall be signed by the civil defense official responsible for the coordination of all civil defense activities in the area concerned.

(c) The application shall be countersigned by the responsible official for the governmental entity served by the civil defense organization.

(d) If the application is for a RACES station to be in any special manner covered by § 97.41, those showings specified for non-RACES stations shall also be submitted.

##### § 97.175 Amateur radio station registration in civil defense organization.

No amateur radio station shall be operated in the Radio Amateur Civil Emergency Service unless it is certified as registered in a civil defense organization by that organization.

#### OPERATING REQUIREMENTS

##### § 97.177 Operator requirements.

No person shall be the control operator of a RACES station, or shall be the control operator of an amateur radio station conducting communications in the Radio Amateur Civil Emergency Service unless that person holds a valid amateur radio operator license and is certified as enrolled in a civil defense organization by that organization.

##### § 97.179 Operator privileges.

Operator privileges in the Radio Amateur Civil Emergency Service are dependent upon, and identical to, those for the class of operator license held in the Amateur Radio Service.

##### § 97.181 Availability of RACES station license and operator licenses.

(a) The original license of each RACES station, or a photocopy thereof, shall be attached to each transmitting station.

ter of such station, and at each control point of such station. Whenever a photocopy of the RACES station license is utilized in compliance with this requirement, the original station license shall be available for inspection by any authorized Government official at all times while the station is being operated and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost, or destroyed, and request has been made for a duplicate license in accordance with § 97.57.

(b) In addition to the operator license availability requirements of § 97.83, a photocopy of the control operator's amateur radio operator license shall be posted at a conspicuous place at the control point for the RACES station.

#### TECHNICAL REQUIREMENTS

##### § 97.185 Frequencies available.

(a) All of the authorized frequencies and emissions allocated to the Amateur Radio Service are also available to the Radio Amateur Civil Emergency Service on a shared basis.

(b) In the event of an emergency which necessitates the invoking of the President's War Emergency Powers under the provisions of § 606 of the Communications Act of 1934 as amended, unless otherwise modified or directed, RACES stations and amateur radio stations participating in RACES will be limited in operation to the following:

LIMITATION		MHz	
1	1	1800-1825	KHz.
1	1	1975-2000	
4	4	3500-3510	
4	4	3510-3516	
2, 4	2, 4	4716-4850	
3	3	3997	
4	4	7097-7103	
2, 4	2, 4	7103-7125	
2, 4	2, 4	7245-7255	
2, 4	2, 4	14047-14053	
2, 4	2, 4	14220-14230	
2, 4	2, 4	21047-21053	
3	3	28.55-28.75	
3	3	29.45-29.65	
3	3	50.35-50.75	
3	3	57.30	
3	3	63.35-63.75	
3	3	146.7-147.33	
3	3	146.79-147.33	
3	3	220-225	

(c) Limitations: (1) Use of frequencies in the band 1800-2000 KHz is subject to the priority of the Loran system of radionavigation in this band and to the geographical, frequency, emission, and power limitations contained in § 97.61 governing amateur radio stations and operators (Subparts A through E of this part).

(2) The availability of the frequency bands 3515-3550 KHz, 7103-7125 KHz, 7245-7247 KHz, 7253-7255 KHz, 7255-7257 KHz, 7257-7259 KHz, 7259-7261 KHz, 7261-7263 KHz, 7263-7265 KHz, 7265-7267 KHz, 7267-7269 KHz, 7269-7271 KHz, 7271-7273 KHz, 7273-7275 KHz, 7275-7277 KHz, 7277-7279 KHz, 7279-7281 KHz, 7281-7283 KHz, 7283-7285 KHz, 7285-7287 KHz, 7287-7289 KHz, 7289-7291 KHz, 7291-7293 KHz, 7293-7295 KHz, 7295-7297 KHz, 7297-7299 KHz, 7299-7301 KHz, 7301-7303 KHz, 7303-7305 KHz, 7305-7307 KHz, 7307-7309 KHz, 7309-7311 KHz, 7311-7313 KHz, 7313-7315 KHz, 7315-7317 KHz, 7317-7319 KHz, 7319-7321 KHz, 7321-7323 KHz, 7323-7325 KHz, 7325-7327 KHz, 7327-7329 KHz, 7329-7331 KHz, 7331-7333 KHz, 7333-7335 KHz, 7335-7337 KHz, 7337-7339 KHz, 7339-7341 KHz, 7341-7343 KHz, 7343-7345 KHz, 7345-7347 KHz, 7347-7349 KHz, 7349-7351 KHz, 7351-7353 KHz, 7353-7355 KHz, 7355-7357 KHz, 7357-7359 KHz, 7359-7361 KHz, 7361-7363 KHz, 7363-7365 KHz, 7365-7367 KHz, 7367-7369 KHz, 7369-7371 KHz, 7371-7373 KHz, 7373-7375 KHz, 7375-7377 KHz, 7377-7379 KHz, 7379-7381 KHz, 7381-7383 KHz, 7383-7385 KHz, 7385-7387 KHz, 7387-7389 KHz, 7389-7391 KHz, 7391-7393 KHz, 7393-7395 KHz, 7395-7397 KHz, 7397-7399 KHz, 7399-7401 KHz, 7401-7403 KHz, 7403-7405 KHz, 7405-7407 KHz, 7407-7409 KHz, 7409-7411 KHz, 7411-7413 KHz, 7413-7415 KHz, 7415-7417 KHz, 7417-7419 KHz, 7419-7421 KHz, 7421-7423 KHz, 7423-7425 KHz, 7425-7427 KHz, 7427-7429 KHz, 7429-7431 KHz, 7431-7433 KHz, 7433-7435 KHz, 7435-7437 KHz, 7437-7439 KHz, 7439-7441 KHz, 7441-7443 KHz, 7443-7445 KHz, 7445-7447 KHz, 7447-7449 KHz, 7449-7451 KHz, 7451-7453 KHz, 7453-7455 KHz, 7455-7457 KHz, 7457-7459 KHz, 7459-7461 KHz, 7461-7463 KHz, 7463-7465 KHz, 7465-7467 KHz, 7467-7469 KHz, 7469-7471 KHz, 7471-7473 KHz, 7473-7475 KHz, 7475-7477 KHz, 7477-7479 KHz, 7479-7481 KHz, 7481-7483 KHz, 7483-7485 KHz, 7485-7487 KHz, 7487-7489 KHz, 7489-7491 KHz, 7491-7493 KHz, 7493-7495 KHz, 7495-7497 KHz, 7497-7499 KHz, 7499-7501 KHz, 7501-7503 KHz, 7503-7505 KHz, 7505-7507 KHz, 7507-7509 KHz, 7509-7511 KHz, 7511-7513 KHz, 7513-7515 KHz, 7515-7517 KHz, 7517-7519 KHz, 7519-7521 KHz, 7521-7523 KHz, 7523-7525 KHz, 7525-7527 KHz, 7527-7529 KHz, 7529-7531 KHz, 7531-7533 KHz, 7533-7535 KHz, 7535-7537 KHz, 7537-7539 KHz, 7539-7541 KHz, 7541-7543 KHz, 7543-7545 KHz, 7545-7547 KHz, 7547-7549 KHz, 7549-7551 KHz, 7551-7553 KHz, 7553-7555 KHz, 7555-7557 KHz, 7557-7559 KHz, 7559-7561 KHz, 7561-7563 KHz, 7563-7565 KHz, 7565-7567 KHz, 7567-7569 KHz, 7569-7571 KHz, 7571-7573 KHz, 7573-7575 KHz, 7575-7577 KHz, 7577-7579 KHz, 7579-7581 KHz, 7581-7583 KHz, 7583-7585 KHz, 7585-7587 KHz, 7587-7589 KHz, 7589-7591 KHz, 7591-7593 KHz, 7593-7595 KHz, 7595-7597 KHz, 7597-7599 KHz, 7599-7601 KHz, 7601-7603 KHz, 7603-7605 KHz, 7605-7607 KHz, 7607-7609 KHz, 7609-7611 KHz, 7611-7613 KHz, 7613-7615 KHz, 7615-7617 KHz, 7617-7619 KHz, 7619-7621 KHz, 7621-7623 KHz, 7623-7625 KHz, 7625-7627 KHz, 7627-7629 KHz, 7629-7631 KHz, 7631-7633 KHz, 7633-7635 KHz, 7635-7637 KHz, 7637-7639 KHz, 7639-7641 KHz, 7641-7643 KHz, 7643-7645 KHz, 7645-7647 KHz, 7647-7649 KHz, 7649-7651 KHz, 7651-7653 KHz, 7653-7655 KHz, 7655-7657 KHz, 7657-7659 KHz, 7659-7661 KHz, 7661-7663 KHz, 7663-7665 KHz, 7665-7667 KHz, 7667-7669 KHz, 7669-7671 KHz, 7671-7673 KHz, 7673-7675 KHz, 7675-7677 KHz, 7677-7679 KHz, 7679-7681 KHz, 7681-7683 KHz, 7683-7685 KHz, 7685-7687 KHz, 7687-7689 KHz, 7689-7691 KHz, 7691-7693 KHz, 7693-7695 KHz, 7695-7697 KHz, 7697-7699 KHz, 7699-7701 KHz, 7701-7703 KHz, 7703-7705 KHz, 7705-7707 KHz, 7707-7709 KHz, 7709-7711 KHz, 7711-7713 KHz, 7713-7715 KHz, 7715-7717 KHz, 7717-7719 KHz, 7719-7721 KHz, 7721-7723 KHz, 7723-7725 KHz, 7725-7727 KHz, 7727-7729 KHz, 7729-7731 KHz, 7731-7733 KHz, 7733-7735 KHz, 7735-7737 KHz, 7737-7739 KHz, 7739-7741 KHz, 7741-7743 KHz, 7743-7745 KHz, 7745-7747 KHz, 7747-7749 KHz, 7749-7751 KHz, 7751-7753 KHz, 7753-7755 KHz, 7755-7757 KHz, 7757-7759 KHz, 7759-7761 KHz, 7761-7763 KHz, 7763-7765 KHz, 7765-7767 KHz, 7767-7769 KHz, 7769-7771 KHz, 7771-7773 KHz, 7773-7775 KHz, 7775-7777 KHz, 7777-7779 KHz, 7779-7781 KHz, 7781-7783 KHz, 7783-7785 KHz, 7785-7787 KHz, 7787-7789 KHz, 7789-7791 KHz, 7791-7793 KHz, 7793-7795 KHz, 7795-7797 KHz, 7797-7799 KHz, 7799-7801 KHz, 7801-7803 KHz, 7803-7805 KHz, 7805-7807 KHz, 7807-7809 KHz, 7809-7811 KHz, 7811-7813 KHz, 7813-7815 KHz, 7815-7817 KHz, 7817-7819 KHz, 7819-7821 KHz, 7821-7823 KHz, 7823-7825 KHz, 7825-7827 KHz, 7827-7829 KHz, 7829-7831 KHz, 7831-7833 KHz, 7833-7835 KHz, 7835-7837 KHz, 7837-7839 KHz, 7839-7841 KHz, 7841-7843 KHz, 7843-7845 KHz, 7845-7847 KHz, 7847-7849 KHz, 7849-7851 KHz, 7851-7853 KHz, 7853-7855 KHz, 7855-7857 KHz, 7857-7859 KHz, 7859-7861 KHz, 7861-7863 KHz, 7863-7865 KHz, 7865-7867 KHz, 7867-7869 KHz, 7869-7871 KHz, 7871-7873 KHz, 7873-7875 KHz, 7875-7877 KHz, 7877-7879 KHz, 7879-7881 KHz, 7881-7883 KHz, 7883-7885 KHz, 7885-7887 KHz, 7887-7889 KHz, 7889-7891 KHz, 7891-7893 KHz, 7893-7895 KHz, 7895-7897 KHz, 7897-7899 KHz, 7899-7901 KHz, 7901-7903 KHz, 7903-7905 KHz, 7905-7907 KHz, 7907-7909 KHz, 7909-7911 KHz, 7911-7913 KHz, 7913-7915 KHz, 7915-7917 KHz, 7917-7919 KHz, 7919-7921 KHz, 7921-7923 KHz, 7923-7925 KHz, 7925-7927 KHz, 7927-7929 KHz, 7929-7931 KHz, 7931-7933 KHz, 7933-7935 KHz, 7935-7937 KHz, 7937-7939 KHz, 7939-7941 KHz, 7941-7943 KHz, 7943-7945 KHz, 7945-7947 KHz, 7947-7949 KHz, 7949-7951 KHz, 7951-7953 KHz, 7953-7955 KHz, 7955-7957 KHz, 7957-7959 KHz, 7959-7961 KHz, 7961-7963 KHz, 7963-7965 KHz, 7965-7967 KHz, 7967-7969 KHz, 7969-7971 KHz, 7971-7973 KHz, 7973-7975 KHz, 7975-7977 KHz, 7977-7979 KHz, 7979-7981 KHz, 7981-7983 KHz, 7983-7985 KHz, 7985-7987 KHz, 7987-7989 KHz, 7989-7991 KHz, 7991-7993 KHz, 7993-7995 KHz, 7995-7997 KHz, 7997-7999 KHz, 7999-8001 KHz, 8001-8003 KHz, 8003-8005 KHz, 8005-8007 KHz, 8007-8009 KHz, 8009-8011 KHz, 8011-8013 KHz, 8013-8015 KHz, 8015-8017 KHz, 8017-8019 KHz, 8019-8021 KHz, 8021-8023 KHz, 8023-8025 KHz, 8025-8027 KHz, 8027-8029 KHz, 8029-8031 KHz, 8031-8033 KHz, 8033-8035 KHz, 8035-8037 KHz, 8037-8039 KHz, 8039-8041 KHz, 8041-8043 KHz, 8043-8045 KHz, 8045-8047 KHz, 8047-8049 KHz, 8049-8051 KHz, 8051-8053 KHz, 8053-8055 KHz, 8055-8057 KHz, 8057-8059 KHz, 8059-8061 KHz, 8061-8063 KHz, 8063-8065 KHz, 8065-8067 KHz, 8067-8069 KHz, 8069-8071 KHz, 8071-8073 KHz, 8073-8075 KHz, 8075-8077 KHz, 8077-8079 KHz, 8079-8081 KHz, 8081-8083 KHz, 8083-8085 KHz, 8085-8087 KHz, 8087-8089 KHz, 8089-8091 KHz, 8091-8093 KHz, 8093-8095 KHz, 8095-8097 KHz, 8097-8099 KHz, 8099-8101 KHz, 8101-8103 KHz, 8103-8105 KHz, 8105-8107 KHz, 8107-8109 KHz, 8109-8111 KHz, 8111-8113 KHz, 8113-8115 KHz, 8115-8117 KHz, 8117-8119 KHz, 8119-8121 KHz, 8121-8123 KHz, 8123-8125 KHz, 8125-8127 KHz, 8127-8129 KHz, 8129-8131 KHz, 8131-8133 KHz, 8133-8135 KHz, 8135-8137 KHz, 8137-8139 KHz, 8139-8141 KHz, 8141-8143 KHz, 8143-8145 KHz, 8145-8147 KHz, 8147-8149 KHz, 8149-8151 KHz, 8151-8153 KHz, 8153-8155 KHz, 8155-8157 KHz, 8157-8159 KHz, 8159-8161 KHz, 8161-8163 KHz, 8163-8165 KHz, 8165-8167 KHz, 8167-8169 KHz, 8169-8171 KHz, 8171-8173 KHz, 8173-8175 KHz, 8175-8177 KHz, 8177-8179 KHz, 8179-8181 KHz, 8181-8183 KHz, 8183-8185 KHz, 8185-8187 KHz, 8187-8189 KHz, 8189-8191 KHz, 8191-8193 KHz, 8193-8195 KHz, 8195-8197 KHz, 8197-8199 KHz, 8199-8201 KHz, 8201-8203 KHz, 8203-8205 KHz, 8205-8207 KHz, 8207-8209 KHz, 8209-8211 KHz, 8211-8213 KHz, 8213-8215 KHz, 8215-8217 KHz, 8217-8219 KHz, 8219-8221 KHz, 8221-8223 KHz, 8223-8225 KHz, 8225-8227 KHz, 8227-8229 KHz, 8229-8231 KHz, 8231-8233 KHz, 8233-8235 KHz, 8235-8237 KHz, 8237-8239 KHz, 8239-8241 KHz, 8241-8243 KHz, 8243-8245 KHz, 8245-8247 KHz, 8247-8249 KHz, 8249-8251 KHz, 8251-8253 KHz, 8253-8255 KHz, 8255-8257 KHz, 8257-8259 KHz, 8259-8261 KHz, 8261-8263 KHz, 8263-8265 KHz, 8265-8267 KHz, 8267-8269 KHz, 8269-8271 KHz, 8271-8273 KHz, 8273-8275 KHz, 8275-8277 KHz, 8277-8279 KHz, 8279-8281 KHz, 8281-8283 KHz, 8283-8285 KHz, 8285-8287 KHz, 8287-8289 KHz, 8289-8291 KHz, 8291-8293 KHz, 8293-8295 KHz, 8295-8297 KHz, 8297-8299 KHz, 8299-8301 KHz, 8301-8303 KHz, 8303-8305 KHz, 8305-8307 KHz, 8307-8309 KHz, 8309-8311 KHz, 8311-8313 KHz, 8313-8315 KHz, 8315-8317 KHz, 8317-8319 KHz, 8319-8321 KHz, 8321-8323 KHz, 8323-8325 KHz, 8325-8327 KHz, 8327-8329 KHz, 8329-8331 KHz, 8331-8333 KHz, 8333-8335 KHz, 8335-8337 KHz, 8337-8339 KHz, 8339-8341 KHz, 8341-8343 KHz, 8343-8345 KHz, 8345-8347 KHz, 8347-8349 KHz, 8349-8351 KHz, 8351-8353 KHz, 8353-8355 KHz, 8355-8357 KHz, 8357-8359 KHz, 8359-8361 KHz, 8361-8363 KHz, 8363-8365 KHz, 8365-8367 KHz, 8367-8369 KHz, 8369-8371 KHz, 8371-8373 KHz, 8373-8375 KHz, 8375-8377 KHz, 8377-8379 KHz, 8379-8381 KHz, 8381-8383 KHz, 8383-8385 KHz, 8385-8387 KHz, 8387-8389 KHz, 8389-8391 KHz, 8391-8393 KHz, 8393-8395 KHz, 8395-8397 KHz, 8397-8399 KHz, 8399-8401 KHz, 8401-8403 KHz, 8403-8405 KHz, 8405-8407 KHz, 8407-8409 KHz, 8409-8411 KHz, 8411-8413 KHz, 8413-8415 KHz, 8415-8417 KHz, 8417-8419 KHz, 8419-8421 KHz, 8421-8423 KHz, 8423-8425 KHz, 8425-8427 KHz, 8427-8429 KHz, 8429-8431 KHz, 8431-8433 KHz, 8433-8435 KHz, 8435-8437 KHz, 8437-8439 KHz, 8439-8441 KHz, 8441-8443 KHz, 8443-8445 KHz, 8445-8447 KHz, 8447-8449 KHz, 8449-8451 KHz, 8451-8453 KHz, 8453-8455 KHz, 8455-8457 KHz, 8457-8459 KHz, 8459-8461 KHz, 8461-8463 KHz, 8463-8465 KHz, 8465-8467 KHz, 8467-8469 KHz, 8469-8471 KHz, 8471-8473 KHz, 8473-8475 KHz, 8475-8477 KHz, 8477-8479 KHz, 8479-8481 KHz, 8481-8483 KHz, 8483-8485 KHz, 8485-8487 KHz, 8487-8489 KHz, 8489-8491 KHz, 8491-8493 KHz, 8493-8495 KHz, 8495-8497 KHz, 8497-8499 KHz, 8499-8501 KHz, 8501-8503 KHz, 8503-8505 KHz, 8505-8507 KHz, 8507-8509 KHz, 8509-8511 KHz, 8511-8513 KHz, 8513-8515 KHz, 8515-8517 KHz, 8517-8519 KHz, 8519-8521 KHz, 8521-8523 KHz, 8523-8525 KHz, 8525-8527 KHz, 8527-8529 KHz, 8529-8531 KHz, 8531-8533 KHz, 8533-8535 KHz, 8535-8537 KHz, 8537-8539 KHz, 8539-8541 KHz, 8541-8543 KHz, 8543-8545 KHz, 8545-8547 KHz, 8547-8549 KHz, 8549-8551 KHz, 8551-8553 KHz, 8553-8555 KHz, 8555-8557 KHz, 8557-8559 KHz, 8559-8561 KHz, 8561-8563 KHz, 8563-8565 KHz, 8565-8567 KHz, 8567-8569 KHz, 8569-8571 KHz, 8571-8573 KHz, 8573-8575 KHz, 8575-8577 KHz, 8577-8579 KHz, 8579-8581 KHz, 8581-8583 KHz, 8583-8585 KHz, 8585-8587 KHz, 8587-8589 KHz, 8589-8591 KHz, 8591-8593 KHz, 8593-8595 KHz, 8595-8597 KHz, 8597-8599 KHz, 8599-8601 KHz, 8601-8603 KHz, 8603-8605 KHz, 8605-8607 KHz, 8607-8609 KHz, 8609-8611 KHz, 8611-8613 KHz, 8613-8615 KHz, 8615-8617 KHz, 8617-8619 KHz, 8619-8621 KHz, 8621-8623 KHz, 8623-8625 KHz, 8625-8627 KHz, 8627-8629 KHz, 8629-8631 KHz, 8631-8633 KHz, 8633-8635 KHz, 8635-8637 KHz, 8637-8639 KHz, 8639-8641 KHz, 8641-8643 KHz, 8643-8645 KHz, 8645-8647 KHz, 8647-8649 KHz, 8649-8651 KHz, 8651-8653 KHz, 8653-8655 KHz, 8655-8657 KHz, 8657-8659 KHz, 8659-8661 KHz, 8661-8663 KHz, 8663-8665 KHz, 8665-8667 KHz, 8667-8669 KHz, 8669-8671 KHz, 8671-8673 KHz, 8673-8675 KHz, 8675-8677 KHz, 8677-8679 KHz, 8679-8681 KHz, 8681-8683 KHz, 8683-8685 KHz, 8685-8687 KHz, 8687-8689 KHz, 8689-8691 KHz, 8691-8693 KHz, 8693-8695 KHz, 8695-8697 KHz, 8697-8699 KHz, 8699-8701 KHz, 8701-8703 KHz, 8703-8705 KHz, 8705-8707 KHz, 8707-8709 KHz, 8709-8711 KHz, 8711-8713 KHz, 8713-8715 KHz, 8715-8717 KHz, 8717-8719 KHz, 8719-8721 KHz, 8721-8723 KHz, 8723

Stations in this service may transmit only civil defense communications of the following types:

- (a) Communications concerning impending or actual conditions jeopardizing the public safety, or affecting the national defense or security during periods of local, regional, or national civil emergencies.
- (1) Communications directly concerning the immediate safety of life or individuals, the immediate protection of property, maintenance of law and order, alleviation of human suffering and need, and the combating of armed attack or sabotage;
- (2) Communications directly concerning the accumulation and dissemination of public information or instructions to the civilian population essential to the activities of the civil defense organization or other authorized governmental or relief agencies.
- (b) Communications for training drills and tests necessary to ensure the establishment and maintenance of orderly and efficient operation of the Radio Amateur Civil Emergency Service as ordered by the responsible civil defense organization served. Such tests and drills may not exceed a total time of one hour per week.
- (c) Brief one way transmissions for the testing and adjustment of equipment.

#### § 97.193 Limitations on the use of RACES stations.

- (a) No station in the Radio Amateur Civil Emergency Service shall be used to transmit or to receive messages for hire, nor for communications for material compensation, direct or indirect, paid or promised.
- (b) All messages which are transmitted in connection with drills or tests shall be clearly identified as such by use of the words "drill" or "test", as appropriate, in the body of the messages.

### SUBPART G—OPERATION OF AMATEUR RADIO STATIONS IN THE UNITED STATES BY ALIENS PURSUANT TO RECIPROCAL AGREEMENTS

#### § 97.301 Basis, purpose, and scope.

- (a) The rules in this subpart are based on, and are applicable solely to, alien amateur operations pursuant to section 303(i)(3) and 310(a) of the Communications Act of 1934, as amended. (See Pub. L. 93-506, 88 Stat. 1576.)

- (b) The purpose of this subpart is to implement Public Law 88-313 by prescribing the rules under which an alien, who holds an amateur operator and station license issued by his government (hereafter referred to as an alien amateur), may operate an amateur radio station in the United States, in its possessions, and in the Commonwealth of Puerto Rico (hereafter referred to only as the United States).

#### § 97.303 Permit required.

- (a) Before he may operate an amateur radio station in the United States, under the provisions of sections

#### § 97.189 Points of communications.

- (3) For use in emergency areas when required to make initial contact with a military unit; also, for communications with military stations on matters requiring coordination.
- (4) For use by all authorized stations only in the continental United States, except that the bands 7245-7255 kHz and 14220-14230 kHz are also available in Alaska, Hawaii, Puerto Rico, and the Virgin Islands.
- (5) Those stations operating in the band 220-225 MHz shall not cause harmful interference to the government radiolocation service.

- (a) RACES stations may only be used to communicate with:

- (1) Other RACES stations;

- (2) Amateur radio stations certified as being registered with a civil defense organization, by that organization;

- (3) Stations in the Disaster Communications Service; (4) Stations of the United States Government authorized by the responsible agency to exchange communications with RACES stations;

- (5) Any other station in any other service regulated by the Federal Communications Commission, whenever such station is authorized by the Commission, to exchange communications with stations in the Radio Amateur Civil Emergency Service.

- (b) Amateur radio stations registered with a civil defense organization may only be used to communicate with:

- (1) RACES stations licensed to the civil defense organization with which the amateur radio station is registered;

- (2) Any of the following stations upon authorization of the responsible civil defense official for the organization in which the amateur radio station is registered:

- (i) Any RACES station licensed to other civil defense organizations,

- (ii) Amateur radio stations registered with the same or another civil defense organization;

- (iii) Stations in the Disaster Communications Service; (iv) Stations of the United States Government authorized by the responsible agency to exchange communications with RACES stations;

- (v) Any other station in any other service regulated by the Federal Communications Commission, whenever such station is authorized by the Commission, to exchange communications with stations in the Radio Amateur Civil Emergency Service.

#### § 97.191 Permissible communications.

- All communications in the Radio Amateur Civil Emergency Service must be specifically authorized by the civil defense organization for the area served.

At any time the Commission may, in its discretion, modify, suspend, or cancel any permit issued under this subpart. In this event, the permittee will be notified of the Commission's action by letter mailed to his mailing address in the United States and the

Exam nations for amateur radio operator licenses are conducted at the Commission's office in Washington, D.C., and at each field office of the Commission on the days designated by the Engineer in Charge of each office. Specific dates should be obtained from the Engineer in Charge of the nearest field office of the Commission.

Examinations are also given at prescribed intervals in the cities listed in the Commission's current Examination Schedule, copies of which are available from the Federal Communications Commission Regional Services Division, Washington, D.C. 20554, or from any one of the Commission's field offices listed in § 97.121.



FEDERAL COMMUNICATIONS COMMISSION

APPENDIX 2

Extract from Radio Regulations Annexed to the International Telecommunication Convention (Geneva, 1959)

ARTICLE 41—AMATEUR STATIONS

SECTION 1 Radiocommunications between amateur stations of different countries concerned has notified that it objects to such radiocommunications.

SECTION 2 (1) When transmissions between amateur stations of different countries are permitted, they shall be made in plain language and shall be limited to messages of a technical nature relating to tests and to remarks of a personal character for which, by reason of their unimportant nature, recourse to the public telecommunications service is not justified. It is absolutely forbidden for amateur stations to be used for transmitting international communications on behalf of third parties.

SECTION 3 (1) Any person operating the apparatus of an amateur station shall have proved that he is able to send correctly by hand and to receive correctly by ear, texts in Morse code signals. Administrations concerned may, however, waive this requirement in the case of stations making use exclusively of frequencies above 144 MHz.

SECTION 4 (1) Administrations shall take such measures as they judge necessary to verify the technical qualifications of any person operating the apparatus of an amateur station.

SECTION 5 (1) All the general rules of the Convention and of these Regulations shall apply to amateur stations. In particular, the emitted frequency shall be as stable and as free from spurious emissions as the state of technical development for such stations permits.

SECTION 6 (2) During the course of their transmissions, amateur stations shall transmit their call sign at short intervals.

RESOLUTION NO 10

Relating to the use of the bands 7000 to 7100 KHz and 7100 to 7300 KHz by the Amateur Service and the Broadcasting Service

The Administrative Radio Conference Geneva, 1959.

Considerations—

(a) That the sharing of frequency bands by amateur, fixed, and broadcasting services is undesirable and should be avoided, (b) That it is desirable to have worldwide exclusive allocations for these services in Band 7, (c) That the band 7000 to 7100 KHz is allocated on a worldwide basis exclusively to the amateur service, (d) That the band 7100 to 7300 KHz is located in Regions 1 and 3 to the broadcasting service and in Region 2 to the amateur service.

Resolution, that the broadcasting service should be prohibited from the band 7000 to 7100 KHz and that broadcasting stations operating on frequencies in this band should cease such operation, and noting, the provisions of No 117 of the Radio Regulations, that interference to amateur contacts should be only in the band 7000 to 7100 KHz and that the administrations should make every effort to ensure that the broadcasting service in the band 7100 to 7300 KHz, in Regions 1 and 3 does not cause interference to the amateur service in Region 2, such being consistent with the provisions of No 117 of the Radio Regulations.

Radio Regulations

APPENDIX 3

CLASSIFICATION OF EMISSIONS

For convenient reference the tabulation below is extracted from the classification of types, emissions in Part 2 of the Commission's Rules and Regulations and in the Radio Regulations, Geneva, 1959, and it includes only those general classifications which appear most applicable to the Amateur Radio Service.

As may appear in public notices issued by the Commission



Type of modulation	Type of transmission	Sym-bol
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Amplitude	With no modulation	A0
	Telegraph without the use of modulating audio frequency (by on-off keying)	A1
	Telegraph by the on-off keying of an amplitude modulating and a frequency modulating emission (special case)	A2
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A3
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A4
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A5
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A6
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A7
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A8
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A9
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A10
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A11
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A12
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A13
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A14
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A15
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A16
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A17
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A18
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A19
	Telegraph by the on-off keying of a frequency modulating emission (special case)	A20
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ARTICLE III

APPENDIX 4

Convention Between the United States of America and Canada, Relating to the Operation by Citizens of Either Country of Certain Radio Equipment or Stations in the Other Country (Effective May 15, 1957)

It is agreed that persons holding appropriate amateur licenses issued by either country may operate their amateur stations in the territory of the other country under the following conditions (a) Each visiting amateur may be required to register and receive a permit before operating any amateur station licensed by his government (b) The visiting amateur will identify his station by (1) Radiotelegraph operation. The amateur call sign issued to him by the licensing country followed by a sign (i) sign and the amateur call sign prefix and call area number of the country he is visiting (2) Radiotelephone operation. The amateur call sign in English issued to him by the licensing country followed by the words, "fixed", "portable", or "mobile", as appropriate, and the amateur call sign prefix and call area number of the country he is visiting (c) Each amateur station shall indicate at least once during each contact with another station its geographical location as nearly as possible by city and state or city and province (d) In other respects the amateur station shall be operated in accordance with the laws and regulations of the country in which the station is temporarily located

APPENDIX 5

DETERMINATION OF ANTENNA HEIGHT ABOVE AVERAGE TERRAIN

The effective height of the transmitting antenna shall be the height of the antenna's center of radiation above "average terrain." For this purpose, "effective height" shall be established as follows (a) On a U.S. Geological Survey Map having a scale of 1:250,000, lay out eight evenly spaced radials, extending from the transmitter site to a distance of 10 miles and beginning at 0°, 45°, 90°, 135°, 180°, 225°, 270°, 315° (°) If preferred, maps of greater scale may be used (b) By reference to the map contour lines, establish the ground elevation above mean sea level (AMSL) at 2, 4, 6, 8, and 10 miles from the antenna structure along each radial. If no elevation figure or contour line exists for any particular point, the nearest contour line elevation shall be employed (c) Calculate the arithmetic average of these 40 points of elevation (5 points of each of 8 radials)



## RULES AND REGULATIONS

(d) The height above average terrain of the antenna is thus the height AMSL of the antenna's center of radiation, minus the height of average terrain as calculated above.

NOTE 1: Where the transmitter is located near a large body of water, certain points of established elevation may fall over water. Where it is expected that service would be provided to land areas beyond the body of water, the points at water level in that direction should be included.

in the calculation of average elevation. Where it is expected that service would not be provided to land areas beyond the body of water, the points at water level should not be included in the average.

NOTE 2: In instances in which this procedure might provide unreasonable figures due to the unusual nature of the local terrain, applicant may provide additional data at his own discretion, and such data may be considered if deemed significant.



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